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Washington, D. C.

March 1963

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VOLUME IV, NUMBER 1
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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service • **Division of Radiological Health**

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SECTION I.—AIR AND FALLOUT

Fission Product Beta Activity in Airborne Particulates and Precipitation

Surveillance of gross beta activity in air and precipitation provides quick and sensitive detection of fission product activity fluctuations in the environment. Although this information alone does not permit direct evaluation of biological effects, it is widely used in warning systems and programs for investigating patterns and trends in fallout distribution. In this issue, September results from several of these surveillance programs appear under the following titles: "The 80th Meridian (West) Sampling Program," "National Air Sampling Network," and "Canadian Radioactive Fallout Study Program." The September data from the Radiation Surveillance Network were published in the December 1962 *Radiological Health Data.*

THE 80TH MERIDIAN (WEST) SAMPLING PROGRAM
September 1962

U.S. Naval Research Laboratory

Radioactivity measurements of surface air samples collected at various sites near the 80th Meridian (West) have been made since 1956. Sampling locations are shown in figure 1. This program is operated by the U.S. Naval Research Laboratory (NRL)* with the cooperation of interested agencies of the United States, Canada, Ecuador, Peru, Bolivia, and Chile, which collect the samples and forward them to NRL for analysis. Partial financial support of

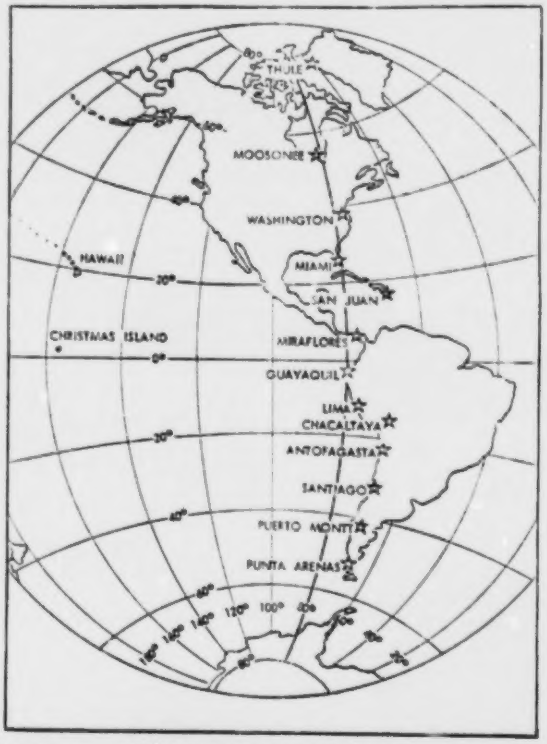

FIGURE 1.—ATMOSPHERIC RADIOACTIVITY SAMPLING STATIONS NEAR THE 80TH MERIDIAN (WEST)

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* Editor's note: Effective January 1, 1963, administration of the 80th Meridian (West) Sampling Program was turned over to the Health and Safety Laboratory, Division of Biology and Medicine, AEC, by the U.S. Naval Research Laboratory.

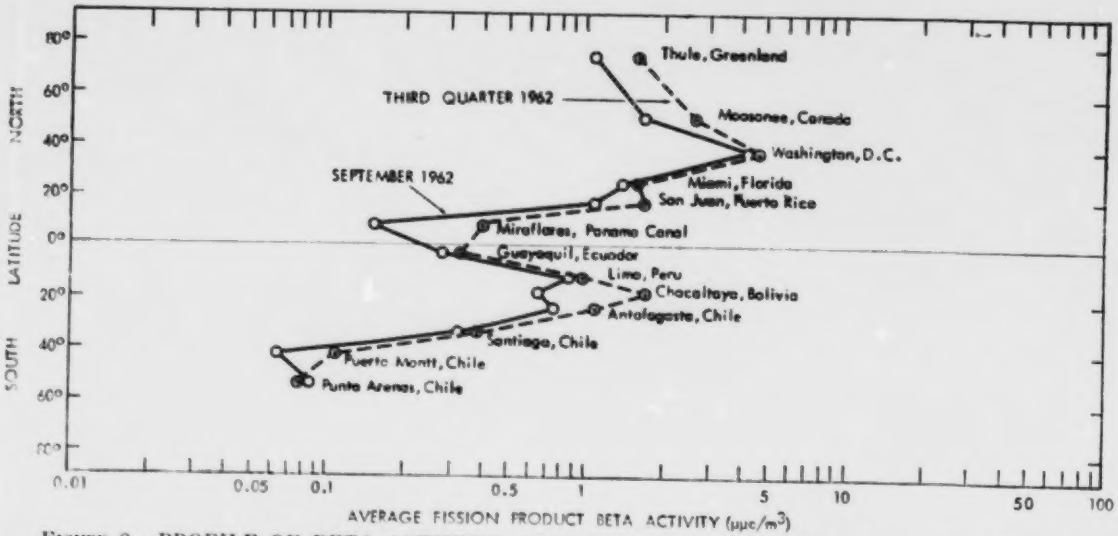

FIGURE 2.—PROFILE OF BETA ACTIVITY, AVERAGE MEASUREMENT OF SURFACE AIR AT STATIONS NEAR THE 80TH MERIDIAN (WEST) SEPTEMBER 1962

this program is provided by the Division of Biology and Medicine, U.S. Atomic Energy Commission.

The sampling procedure involves drawing air continuously for a 7-day period, at a rate of approximately 1200 cubic meters per day through an 8-inch diameter, high-efficiency filter, using a positive displacement blower.

TABLE 1.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, NRL, SEPTEMBER 1962[a]

[Average concentrations in μμc/m³]

September 1962	Punta Arenas, Chile	Puerto Montt, Chile	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador	Miraflores, Panama Canal Zone	San Juan, P. R.	Mauna Loa, Hawaii[b]	Miami, Florida	Washington, D. C.	Moosonee, Canada	Thule, Greenland
1 2 3	0.030	0.060	0.430	0.900	1.26	0.954	0.404	0.167	1.41	[c] —	0.639	5.00	2.60	1.45
4 5 6 7 8 9 10	0.080	0.031	0.279	0.756	0.792	1.00	0.342	0.205	—	1.50	1.80	4.26	1.63	0.268
11 12 13 14 15 16 17	0.069	0.094	0.222	0.625	0.621	0.828	0.316	0.146	1.14	1.02	2.12	4.99	0.932	0.507
18 19 20 21 22 23 24	0.055	—	0.371	0.697	0.342	0.774	0.273	0.090	1.14	1.04	0.932	4.03	1.84	1.21
25 26 27 28 29 30	0.139	—	0.398	0.868	0.630	0.828	0.122	0.157	0.77	0.868	0.860	2.19	1.87	2.06
Weighted average	0.085	0.063	0.326	0.747	0.662	0.868	0.282	0.151	1.08	1.11	1.36	4.04	1.66	1.02

[a] The average concentration determined from a given sample is placed at the center of a rectangle which indicates the length and dates of the sampling period. Station averages for the month were determined by weighting the sample average according to the number of days in the sampling period or that portion of the sampling period occurring in September 1962.

[b] Mauna Loa data have been included for comparison with Chacaltaya, Bolivia. Both are high-elevation stations (3400 and 5200 meters) and about equally distant north and south of the equator.

[c] Dash indicates samples were not received.

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After the 7-day period, the filter is removed and forwarded to NRL for assay of gross beta activity. A minimum of 2 weeks after collection is allowed for decay of short-lived radionuclides. Data are not extrapolated to time of collection.

NATIONAL AIR SAMPLING NETWORK

Third Quarter 1962

Division of Air Pollution, Public Health Service

The National Air Sampling Network was organized in 1953 to secure basic data on the nature and extent of air pollution throughout the United States, and to detect trends in levels of pollution with respect to time, location, population density, climate, and other factors associated with air quality. The network stations are manned by cooperating Federal, State, and local agencies. All samples are analyzed at the Network laboratory in Cincinnati, Ohio.

The current basic network consists of 110 sampling stations operating every year in 73 large cities and 37 nonurban areas. In addition to these every-year stations, 130 cities have stations which operate every other year. Thus, there are 240 sampling stations in all, of which about 175 are active in any given year.

Continuous 24-hour samples of suspended particulate matter, representing approximately 2,000 cubic meters of air, are collected on glass fiber filters on a biweekly random sampling schedule. The analyses of these samples include the measurement of total quantity of suspended particulate matter, the benzene soluble organic matter, and gross beta radioactivity. Selected samples are analyzed also for nitrates, sulfates, and a number of metals.

Gross Beta Activity in Air

Gross beta activity data, by States for 1953 through 1958, were submitted by the Division

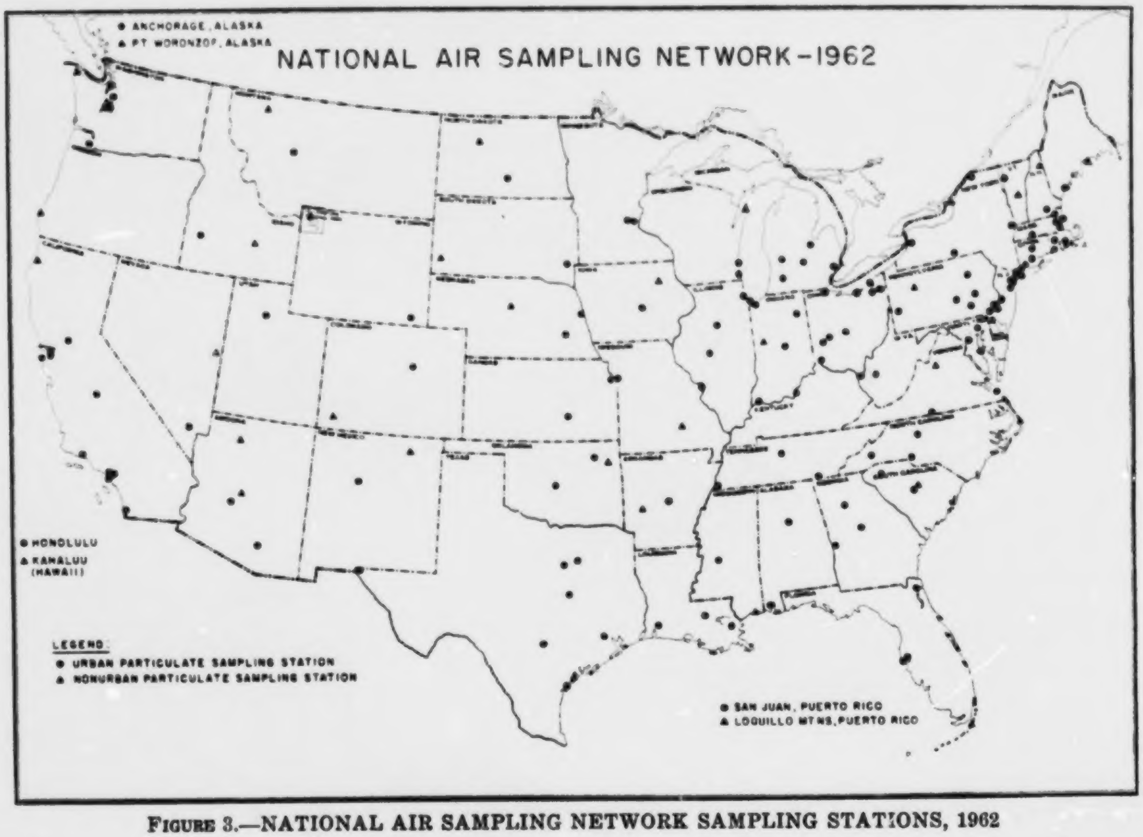
● ANCHORAGE, ALASKA
▲ PT WORONZOF, ALASKA
NATIONAL AIR SAMPLING NETWORK-1962
● HONOLULU
▲ KAMALUU (HAWAII)
LEGEND:
● URBAN PARTICULATE SAMPLING STATION
▲ NONURBAN PARTICULATE SAMPLING STATION
● SAN JUAN, PUERTO RICO
▲ LOQUILLO MTNS, PUERTO RICO

FIGURE 3.—NATIONAL AIR SAMPLING NETWORK SAMPLING STATIONS, 1962

TABLE 2.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, NASN, THIRD QUARTER, 1962

[Concentrations in pc/m³]

Station location		No. of Samples	Minimum	Maximum	Average
Alabama:	Birmingham	7	0.3	11.6	4.7
	Mobile	6	1.1	14.2	4.7
Alaska:	Anchorage	5	0.2	3.2	1.4
	Pt. Woronzof*	5		2.8	1.7
Arizona:	Grand Canyon Pk.*	6	1.2	14.2	6.9
	Maricopa Co.*	6	0.9	6.2	3.6
	Phoenix	7	0.7	9.2	4.1
	Tucson	6	2.5	3.6	3.0
Arkansas:	Little Rock	6	0.2	10.5	3.9
	Montgomery Co.*	5	0.3	4.6	2.7
California:	Burbank	6	2.7	4.5	3.5
	Fresno	6	2.4	8.9	4.9
	Humboldt Co.*	3	0.2	1.4	0.8
	Los Angeles	6	1.2	4.8	2.7
	Oakland	6	1.1	4.1	2.5
	Pasadena	6	1.8	5.7	3.2
	Richmond	5	0.1	2.1	0.9
	Sacramento	7	1.3	5.3	3.1
	San Diego	5	1.1	4.3	2.7
	San Francisco	7	0.5	4.2	1.7
	Santa Barbara	6	0.7	6.3	2.4
Colorado:	Denver	7	1.4	14.3	4.6
	Montezuma Co.*	5	2.1	11.8	4.8
Connecticut:	Bridgeport	6	0.4	7.1	4.1
	Hartford	7	0.3	5.9	2.6
	New Haven	6	0.7	5.6	3.6
	Stamford	7	1.1	3.6	2.3
Delaware:	Kent Co.*	6	0.3	7.1	3.3
	Wilmington	6	0.9	3.8	2.8
District of Columbia:	Washington	6	2.8	14.0	5.8
Florida:	Florida Keys*	6	0.5	3.2	1.5
	Jacksonville	6	1.0	5.5	2.4
	Orlando	4	1.5	1.9	1.7
	St. Petersburg	7	1.0	7.2	2.9
	Tampa	7	0.6	6.3	2.6
Georgia:	Atlanta	6	0.9	4.6	2.7
	Columbus	6	1.5	10.2	5.4
	Macon	5	1.7	3.2	2.4
Hawaii:	Honolulu	7	0.7	4.6	1.7
	Kahaluu*	5	1.0	2.6	1.9
Idaho:	Boise	6	2.9	11.6	6.0
	Butte Co.*	7	2.4	11.0	5.9
Illinois:	Chicago	7	1.1	5.5	3.2
	Cicero	4	1.3	5.7	3.6
	Peoria	6	1.7	5.3	2.9
	Springfield	5	1.9	5.9	3.1
Indiana:	East Chicago	5	2.0	5.1	2.9
	Evansville	5	0.2	5.1	2.6
	Fort Wayne	6	1.7	4.9	2.8
	Gary	5	1.5	3.3	2.6
	Indianapolis	6	1.8	4.7	2.8
	Parke Co.*	6	1.9	6.6	3.4
Iowa:	Delaware Co.*	4	1.8	2.6	2.2
	Des Moines	6	1.7	8.2	3.9
Kansas:	Kansas City	5	2.3	7.0	5.5
	Wichita	6	1.7	5.8	2.8
Kentucky:	Louisville	5	1.8	6.3	3.2
Louisiana:	Baton Rouge	6	1.2	4.3	3.0
	Lake Charles	6	0.5	5.5	2.6
	New Orleans	6	0.7	3.8	2.1
Maine:	Acadia Nat. Pk.*	4	0.2	3.0	2.1
	Portland	5	0.9	5.4	3.2
Maryland:	Baltimore	6	3.8	7.6	5.2
	Calvert Co.*	6	2.4	5.4	3.7
Massachusetts:	Boston	5	1.0	5.6	3.4
	Fall River	7	0.1	9.0	3.7
	Lawrence	6	0.5	9.9	4.2
	Lynn	6	0.8	9.7	3.8
	Quincy	5	0.4	6.4	3.5
	Somerville	5	0.3	6.0	4.0
	Springfield	7	2.3	8.9	4.8

* Nonurban station.

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TABLE 2.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, NASN, THIRD QUARTER, 1962—Con.

[Concentrations in pc/m³]

Station location		No. of Samples	Minimum	Maximum	Average
Michigan:	Detroit	5	1.8	4.4	3.2
	Grand Rapids	5	0.7	4.3	2.4
	Kalamazoo	7	1.8	5.2	3.9
	Lansing	6	1.2	11.3	4.3
	Saginaw	6	2.2	6.5	4.1
Minnesota:	Minneapolis	7	1.8	6.4	3.8
	St. Paul	7	1.8	13.8	5.5
Mississippi:	Jackson	6	0.8	14.2	3.7
	Jackson Co.*	4	0.4	2.7	1.5
Missouri:	Kansas City	5	2.0	8.4	6.3
	Shannon Co.*	4	1.7	10.6	6.4
	St. Louis	7	1.9	6.2	3.7
Montana:	Glacier Nat'l. Pk.*	6	0.4	3.0	1.9
	Helena	6	4.5	12.0	6.4
Nebraska:	Lincoln	6	0.9	4.9	2.7
	Omaha	5	2.5	6.1	3.9
	Thomas Co.*	6	1.8	6.5	3.6
Nevada:	Las Vegas	2	2.8	15.7	9.3
	White Pine Co.*	5	3.5	7.4	6.3
New Hampshire:	Manchester	4	1.1	4.3	3.1
	Coos Co.*	5	1.8	5.0	3.3
New Jersey:	Camden	6	2.5	5.6	3.8
	East Orange	4	2.9	4.6	3.8
	Elizabeth	6	1.7	8.1	4.1
	Newark	6	2.0	6.2	3.5
	Trenton	4	2.1	5.4	3.7
New Mexico:	Albuquerque	6	1.9	4.3	3.2
	Colfax Co.*	6	1.4	6.3	3.0
New York:	Cape Vincent*	6	1.8	4.9	3.5
	Glen Cove	4	1.1	5.3	2.8
	Massena	6	1.4	5.3	2.7
	New York	5	3.1	6.5	4.8
	Niagara Falls	3	1.5	4.7	2.6
	Rochester	6	0.8	3.8	2.1
	Troy	4	2.1	6.0	4.2
North Carolina:	Asheville	7	1.5	8.5	5.0
	Cape Hatteras*	6	2.2	6.4	4.1
	Charlotte	7	1.2	6.5	3.9
	Winston Salem	7	2.8	7.7	5.7
North Dakota:	Bismarck	6	2.9	7.1	4.6
	Ward Co.*	7	2.5	6.3	3.8
Ohio:	Akron	7	0.7	8.1	3.2
	Cincinnati	7	2.2	9.6	4.5
	Cleveland	6	2.0	9.7	5.7
	Columbus	6	2.5	6.0	4.2
	Dayton	7	1.0	4.6	2.8
	Lorain	6	2.3	4.3	3.0
	Springfield	6	1.5	6.3	3.4
	Toledo	7	2.9	8.9	4.6
	Youngstown	6	2.2	5.4	3.5
Oklahoma:	Cherokee Co.*	6	0.4	8.3	3.2
	Oklahoma City	6	0.7	4.7	2.5
	Tulsa	7	0.8	4.3	2.8
Oregon:	Curry Co.*	3	0.3	0.9	0.5
	Portland	5	0.8	3.0	2.0
Pennsylvania:	Clarion Co.*	5	1.2	4.2	2.8
	Harrisburg	4	2.0	5.6	3.3
	Lancaster	7	4.5	11.9	6.6
	Philadelphia	6	1.2	8.0	4.7
	Pittsburgh	6	1.7	7.8	4.5
	Reading	5	0.5	5.3	3.2
	Wilkes Barre	6	2.6	6.6	3.9
Puerto Rico:	Loquillo Mtns.*	5	1.2	3.3	2.1
	San Juan	5	0.6	3.8	2.2
Rhode Island:	Providence	6	0.7	5.1	3.5
	Washington Co.*	7	0.9	4.1	2.7
South Carolina:	Columbia	6	1.7	6.6	4.4
	Greenville	6	1.2	10.3	4.3
	Richland Co.*	6	1.0	8.4	4.0
South Dakota:	Black Hills Forest*	6	2.1	3.2	4.4
	Sioux Falls	4	2.8	7.5	4.1

* Nonurban station.

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TABLE 2.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, NASN, THIRD QUARTER, 1962—Con.

[Concentrations in pc/m³]

Station location		No. of Samples	Minimum	Maximum	Average
Tennessee:	Chattanooga	7	0.9	6.8	3.1
	Memphis	6	0.7	6.9	3.8
	Nashville	7	0.7	6.3	3.8
Texas:	Arkansas Co.*	5	0.7	3.5	2.3
	Corpus Christi	7	0.8	4.0	2.3
	Dallas	5	0.7	5.6	3.0
	El Paso	6	1.6	5.7	2.9
	Ft. Worth	5	0.7	3.1	2.0
	Houston	6	0.7	3.3	2.4
	San Antonio	5	1.1	2.9	2.0
	Waco	6	0.6	6.0	2.9
Utah:	Salt Lake City	7	2.6	9.8	5.9
Vermont:	Burlington	4	4.7	5.9	5.4
	Orange Co.*	7	1.9	7.3	3.8
Virginia:	Danville	6	2.1	14.3	5.[illegible]
	Norfolk	7	0.4	5.8	4.3
	Shenandoah Natl. Pk.*	6	3.4	8.2	5.1
Washington:	Clallam Co.*	3	0.2	1.3	0.9
	Seattle	7	0.5	2.7	1.2
	Tacoma	6	1.0	3.0	1.8
West Virginia:	Charleston	6	0.4	7.8	3.9
	Huntington	6	2.0	8.6	3.9
Wisconsin:	Door Co.*	5	0.6	5.5	3.1
	Milwaukee	5	1.4	4.7	2.4
	Racine	6	2.0	3.8	2.8
Wyoming:	Cheyenne	6	1.8	4.6	1.3
	Yellowstone Pk.*	4	4.4	10.5	6.7

* Nonurban station.

TABLE 3.—FISSION PRODUCT GROSS BETA ACTIVITY IN PRECIPITATION, NASN, THIRD QUARTER, 1962

Station		July		August		September	
		pc/liter	nc/m²	pc/liter	nc/m²	pc/liter	nc/m²
Alabama:	Montgomery	587	56.1	549	48.9	109	9.3
Florida:	Tampa	487	20.7	137	24.4	106	11.8
Illinois:	Chicago, (Midway)	686	76.9	—	—	—	—
	Chicago, (O'Hare)	743	91.8	—	—	—	—
Louisiana:	Lake Charles	—	—	99	35.6	—	—
Maine:	Caribou	523	88.9	558	36.6	1,133	99.7
Massachusetts:	Nantucket	780	65.5	253	20.0	355	28.8
Michigan:	Sault Ste. Marie	—	—	474	49.8	448	35.8
Minnesota:	St. Cloud	623	79.7	536	40.7	557	37.1
Missouri:	Columbia	966	66.7	—	—	436	65.8
Montana:	Glasgow	510	46.7	—	—	—	—
Nebraska:	Grand Island	663	125.3	—	—	—	—
New York:	Albany	494	22.2	811	48.3	424	36.8
North Carolina:	Cape Hatteras	550	42.4	170	40.8	166	27.7
Ohio:	Cincinnati (Airport)	521	105.6	477	17.3	232	13.5
	Cincinnati (Gest St.)	522	50.9	—	—	—	—
Pennsylvania:	Philadelphia	220	11.4	277	44.0	432	16.5
South Carolina:	Charleston	2,487	358.1	79	23.4	341	25.6
	Greenville	674	55.9	354	36.1	426	24.0
Tennessee:	Nashville	—	—	387	21.7	216	38.9
Texas:	Amarillo	344	42.3	357	15.0	404	21.4
	San Angelo	407	17.9	—	—	224	12.6
Washington:	Tatoosh	—	—	236	27.1	332	17.6

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of Radiological Health, Public Health Service, in testimony before the Joint Committee on Atomic Energy in May 1959.* Subsequent data have been published quarterly in *Radiological Health Data* beginning with the October 1960 issue. Third quarter 1962 data are presented in table 2.

Gross Beta Activity in Precipitation

During 1959 a precipitation collection and analysis program was established by the Weather Bureau Research Station in Cincinnati, Ohio, and the National Air Sampling Network. The collection stations are located at Weather Bureau offices or airport stations. Monthly composite samples of precipitation are collected at 29 stations and forwarded to the Network laboratory for analysis.

Samples are analyzed for total solids and a large number of metals and nonmetals. In addition, each sample is analyzed for fission product gross beta radioactivity if sufficient volume remains after chemical analyses have been made. Third quarter 1962 data are presented in table 3.

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* U.S. Atomic Energy Commission: "Hearings, Fallout from Nuclear Weapons Tests," *1*:173–85 (May 1959).

CANADIAN RADIOACTIVE FALLOUT STUDY PROGRAM

Second and Third Quarters 1962

Department of National Health and Welfare, Ottawa, Canada

As part of its Radioactive Fallout Study Program (RFSP), the Radiation Protection Division, Department of National Health and Welfare, Dominion of Canada, conducts air and precipitation sampling programs. The 24 air and precipitation stations are located at airports, and the equipment is operated by meteorologists of the Meteorological Services Branch of the Department of Transport.

About 653 cubic meters of air are drawn through a high-efficiency 4–inch diameter filter during a 24–hour period. Filters are sent daily to the Radiation Protection Division Laboratory in Ottawa. A 2–inch diameter disk is removed from each filter and counted with a thin end-window Geiger flow counter system, calibrated with a Sr^{90}–Y^{90} standard. Four successive measurements are made on each filter to allow for the presence of natural activities and for the decay of short-lived fission products. The result is extrapolated to the end of the sampling period. Air data for second and third quarters 1962 are presented in table 4.

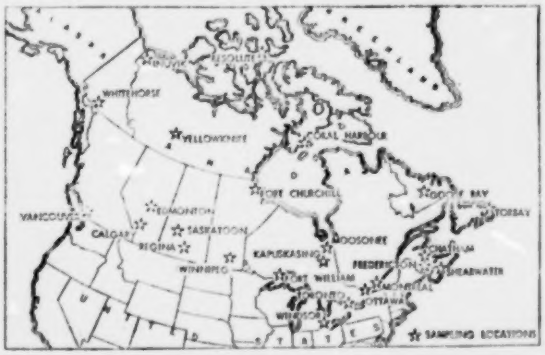

FIGURE 4.—CANADIAN AIR AND PRECIPITATION SAMPLING STATIONS

The amount of radioactive fallout being deposited on the ground is determined from measurements on material collected in special polythene-lined rainfall pots. After transfer of the water to the sampling container, the polythene liner is removed, packed with the sample, and sent to the laboratory. Second and third quarter precipitation data are presented in table 5.

More detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in the Department's annual reports for 1959 and 1960 (*1*, *2*).

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Recent coverage in *Radiological Health Data*:

Period	Issue
First quarter 1961	*December 1961*
Second quarter 1961	*February 1962*
Third quarter 1961	*May 1962*
Fourth quarter 1961	*September 1962*
First quarter 1962	*October 1962*

9<

Table 4.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, RFSP, SECOND AND THIRD QUARTERS 1962

[Average concentrations in $\mu\mu c/m^3$]

Station location	April	May	June	July	August	September
Calgary	8.0	5.1	7.[illegible]	4.7	4.1	13.1
Chatham	5.7	4.8	6.0	3.3	2.3	5.7
Coral Harbor	6.1	4.4	3.2	3.9	1.2	5.1
Edmonton	5.1	4.8	5.0	3.4	2.6	7.8
Ft. Churchill	5.5	4.3	* NS	1.7	1.8	5.7
Ft. William	6.7	7.0	7.1	4.6	2.6	6.7
Fredericton	6.4	5.8	6.5	3.1	2.0	5.6
Goose Bay	6.1	3.9	5.2	2.3	1.9	4.2
Inuvik	6.8	3.8	3.4	3.1	2.7	3.0
Kapuskasing	7.5	6.1	7.3	4.6	2.7	6.1
Montreal	6.7	6.6	7.9	4.6	3.4	9.3
Moosonee	7.8	5.8	5.5	4.0	2.0	4.2
Ottawa	6.9	6.5	8.5	5.0	3.4	6.3
Regina	7.5	6.0	7.3	4.8	3.1	12.7
Resolute	7.3	4.5	1.7	2.1	1.4	2.3
Saskatoon	6.2	6.4	7.2	4.1	4.3	9.7
Shearwater	7.3	4.2	6.4	3.3	2.4	4.2
Torbay	5.2	3.2	3.1	2.5	3.1	5.9
Toronto	7.4	6.8	7.7	5.3	3.3	8.7
Vancouver	5.7	4.0	3.9	2.6	1.9	11.0
Whitehorse	4.6	4.5	4.0	3.2	2.7	5.0
Windsor	9.1	7.9	7.6	6.0	3.7	9.1
Winnipeg	6.1	6.0	5.9	4.7	3.1	6.1
Yellowknife	7.0	5.1	5.3	4.2	3.5	9.8
Overall average	6.6	5.3	5.8	3.8	2.7	7.0

*NS denotes no sample.

TABLE 5.—FISSION PRODUCT GROSS BETA ACTIVITY IN PRECIPITATION, RFSP, SECOND AND THIRD QUARTERS 1962

Station location	April		May		June		July		August		September	
	Concentration (μμc/liter)	Deposition (mμc/m²)	Concentration (μμc/liter)	Deposition (mμc/m²)	Concentration (μμc/liter)	Deposition (mμc/m²)	Concentration (μμc/liter)	Deposition (mμc/m²)	Concentration (μμc/liter)	Deposition (mμc/m²)	Concentration (μμc/liter)	Deposition (mμc/m²)
Calgary	1,481	22.2	579	32.9	4,002	180.9	565	18.8	3,533	195.5	37.6	1,397
Chatham	518	60.5	2,915	122.2	1,788	99.4	857	154.2	444	51.9	112.1	1,014
Coral Harbor	2,368	19.8	3,405	45.8	9,328	45.0	1,360	54.2	968	70.8	71.9	1,555
Edmonton	2,990	107.0	2,552	145.8	2,447	190.8	1,549	124.6	2,163	124.1	75.9	2,929
Fredericton	865	83.0	3,767	110.0	2,052	103.7	410	48.4	698	67.3	113.0	1,196
Ft. Churchill	1,516	50.0	1,981	49.3	1,918	166.1	1,388	64.2	792	89.1	75.7	1,923
Ft. William	2,219	122.9	3,297	202.6	3,815	138.6	1,198	104.3	866	107.1	135.3	1,595
Goose Bay	553	34.1	1,482	94.5	1,414	101.9	911	84.6	1,185	63.0	66.9	1,014
Inuvik	547	11.5	3,233	27.1	1,318	59.6	1,409	99.5	1,462	74.7	57.9	2,716
Kapusaking	1,117	43.7	667	115.3	868	44.5	711	85.7	248	39.5	68.6	535
Montreal	1,698	212.2	2,791	109.1	1,099	85.3	866	110.4	979	58.6	96.6	1,398
Moosonee	1,186	34.9	2,811	219.1	980	55.3	942	124.2	1,029	88.1	150.2	1,032
Ottawa	1,721	138.5	2,168	83.1	2,032	148.6	1,204	155.6	1,231	69.1	175.8	2,499
Regina	3,800	83.0	2,120	90.4	3,177	308.1	1,763	90.0	2,380	139.7	46.9	5,281
Resolute	* tp	39.2	4,490	14.8	2,026	12.4	939	16.9	766	8.8	47.0	3,560
Saskatoon	9,439	50.3	1,496	35.3	1,674	164.4	2,110	70.2	2,104	94.6	115.4	4,835
Shearwater	1,161	172.5	2,196	110.5	1,450	133.7	836	113.4	587	73.0	133.6	766
Torbay	1,629	98.9	1,705	73.6	952	92.1	921	130.3	552	30.1	82.3	508
Toronto	2,478	78.6	3,461	97.6	2,534	166.6	1,395	128.2	1,330	52.4	115.1	724
Vancouver	1,560	141.4	1,224	53.2	2,877	60.6	1,003	25.5	1,496	134.5	116.0	1,806
Whitehorse	1,295	17.8	2,472	31.4	2,005	123.8	2,803	51.3	1,173	53.1	53.0	1,899
Windsor	1,938	186.0	2,434	80.3	1,566	198.9	1,506	118.2	759	73.2	133.5	1,695
Winnipeg	2,032	34.6	1,962	259.7	2,155	115.5	1,114	173.0	842	146.1	48.8	3,096
Yellowknife	8,892	13.5	10,894	41.5	2,034	58.4	2,522	78.7	1,386	69.0	49.3	13,864
Average	2,304	77.3	2,745	93.5	2,313	118.9	1,262	92.7	1,207	82.2	90.8	2,452

* tp denotes trace precipitation.

Strontium–90 Deposition on the Earth's Surface*

1958–1961

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Quarterly strontium–90 deposition figures based on the worldwide pot and resin column collections made by the Health and Safety Laboratory (HASL) during 1958, 1959, and 1960, have been reported previously (*1*). Similar data are presented below. The results of strontium–89 determinations, performed on the samples collected during the last four months of that year, are also included.

Until the last half of 1960, the monthly samples were analyzed individually. In anticipation of diminishing fallout rates, the monthly collections were combined on a two-month basis through August 1961. Thereafter, analyses of individual monthly collections were resumed.

Samples collected in 1958 and 1959 were analyzed for strontium–89 and strontium–90. Tungsten–185, produced in the 1958 Hardtack tests, was detectable in fallout during the latter half of 1958 and throughout 1959. Deposition studies at HASL involving these three radionuclides (*2, 3, 4*) were aimed at estimating relative contributions of different sources to total fallout radioactivity. Only strontium–90 was determined in the collections made in 1960, since the activity levels of the shorter-lived nuclides were not detectable.

Average bimonthly (from January through August) and monthly (from September through December) strontium–90 deposition figures in millicuries per square mile for 1961 for each ten degrees of latitude from 50° north to 50° south, are presented in table 1. Data for stations located between 50° and 80° north latitude were combined. The bimonthly and monthly values were summed to give a yearly value for each latitude band. These data are plotted in figure 1 and show the expected lati-

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* U.S. Atomic Energy Commission: *Fallout Program Quarterly Summary Report, HASL–131*:221–9, Office of Technical Services, Department of Commerce, Washington 25, D.C. (October 1, 1962), price $3.50.

TABLE 1.—1961 AVERAGE STRONTIUM-90 FALLOUT BY BANDS OF LATITUDE

[Millicuries Sr^{90} per square mile]

Period	80–50°N	50–40°N	40–30°N	30–20°N	20–10°N	10°N–0	0–10°S	10–20°S	20–30°S	30–40°S	40–50°S
January–February	0.33	0.52	0.53	0.64	0.21	0.23	0.12	0.14	0.33	0.36	0.28
March–April	0.50	1.01	0.78	0.54	0.27	0.35	0.22	0.16	0.30	0.36	0.28
May–June	0.55	0.99	0.74	0.63	0.27	0.41	0.28	0.08	0.15	0.33	0.48
July–August	0.45	0.40	0.33	0.27	0.18	0.19	0.09	0.19	0.17	0.45	0.21
September	0.28	0.21	0.13	0.12	0.14	0.09	0.12	0.10	0.21	0.14	0.13
October	0.38	0.43	0.18	0.28	0.13	0.08	0.03	0.33	0.33	0.27	0.22
November	0.49	0.70	0.66	0.38	0.24	0.20	0.29	0.25	0.36	0.33	0.08
December	0.59	0.95	0.91	0.69	0.23	0.40	0.34	0.12	0.40	0.25	0.18
Total during 1961	3.57	5.21	4.26	3.55	1.67	1.95	1.49	1.37	2.25	2.49	1.86

tudinal deposition profile (*5*). A maximum at 40°–50° north, a minimum in the equatorial regions, and a slight rise from 20°–40° in the southern hemisphere can be noted.

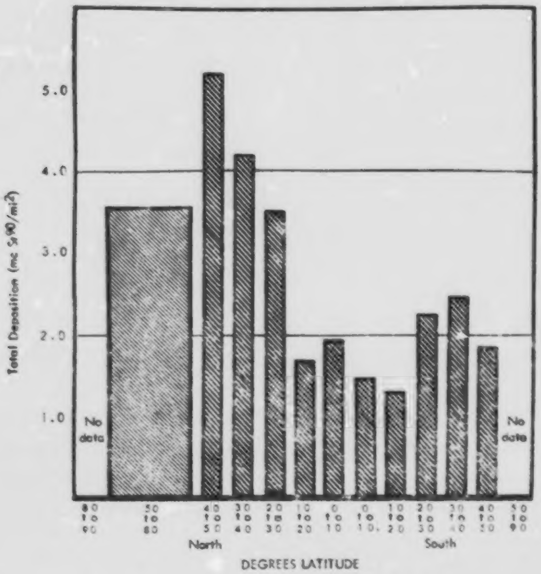

FIGURE 1.—TOTAL STRONTIUM-90 DEPOSITION DURING 1961, BY LATITUDE BAND

It is important to note that the sampling sites, from a climatic standpoint, were assumed to be representative of the latitude band in which they are located. The values were not corrected for differences in precipitation since rainfall information is lacking in a considerable number of cases. Kosta Telegadas of the U.S. Weather Bureau has used two methods to average the data in order to compute the total global ground fallout (*6, 7, 8, 9*). The first method involves the determination of the arithmetic average deposition for each 10 degrees of latitude and the drawing of a smooth curve through the points. This method assumes (as in this presentation) that the arithmetic average of the selected sites is representative of the average value for the whole latitude band. The second method attempts to compensate for the climatic differences by using the average rainfall in a latitude band. The smoothed latitudinal curves of deposition for the two methods are integrated to give the global fallout in megacuries of strontium–90. In this report, the arithmetic average fallout rate for each latitude band has been multiplied directly by the area of the band to give the total activity of strontium–90 deposited. These values for 1961, reported in megacuries, are given in table 2.

In table 3, estimates are given of the total strontium–90 deposition in the northern and southern hemispheres by quarters since 1958. These figures include only the land areas of the earth covered by the pot and resin column collectors, i.e. 80° north to 50° south, and no attempt was made to extrapolate the available data to include those latitudes not covered by

TABLE 2.—1961 ARITHMETIC AVERAGE STRONTIUM-90 FALLOUT, BY BANDS OF LATITUDE

[Megacuries]

Latitude band	80–50°N	50–40°N	40–30°N	30–20°N	20–10°N	10°N–0	0–10°S	10–20°S	20–30°S	30–40°S	40–50°S
Total deposition	0.077	0.064	0.060	0.055	0.028	0.033	0.025	0.023	0.035	0.035	0.023
Number of sites	12	25	19	14	10	13	9	7	8	7	2

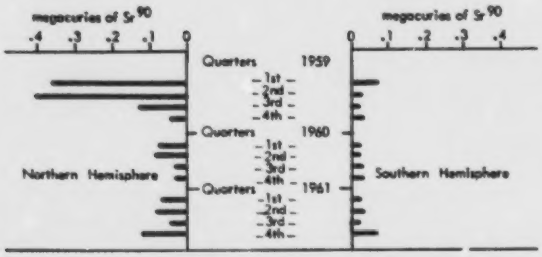

FIGURE 2.—QUARTERLY DEPOSITION OF STRONTIUM-90, 1959-1961

the sampling network. In 1958, the number of sampling stations was too sparse to treat the northern and southern hemispheres separately.

The quarterly strontium-90 deposition, including time of deposition from 1958 through 1961 is plotted in figure 2 for the northern and southern hemispheres. The heaviest fallout occurred during the first six months of 1959 in the northern hemisphere and was followed by a sharp decline during the latter half of the year. During the last quarter of 1959, the deposition in the northern hemisphere was very nearly the same as that which had been characteristic of the southern hemisphere since April. The seasonal rise in the northern hemisphere was very much in evidence during 1960 and 1961. One interesting point is that the spring increase in 1961 was only slightly less than that observed in 1960. The deposition rate in the southern hemisphere appears to have remained rather constant through 1960 and the first nine months of 1961. The increase in the northern hemisphere during the last quarter of 1961 is attributed to the resumption of weapons testing in September, but the apparent increase in the southern hemisphere probably involves an influx of old debris as well as a contribution from the 1961 testing.

TABLE 3.—ESTIMATES OF TOTAL STRONTIUM-90 DEPOSITION BY HEMISPHERE AND QUARTER

[Megacuries]

Period	Northern Hemisphere	Southern Hemisphere	Northern and Southern Hemispheres
1958			
First quarter			0.14
Second quarter			0.24
Third quarter			0.18
Fourth quarter			0.21
Total			0.77
1959			
First quarter	0.36	0.066	0.43
Second quarter	0.41	0.025	0.43
Third quarter	0.12	0.025	0.14
Fourth quarter	0.04	0.033	0.08
Total	0.93	0.149	1.08
1960			
First quarter	0.079	0.027	0.106
Second quarter	0.086	0.022	0.108
Third quarter	0.036	0.022	0.058
Fourth quarter	0.029	0.035	0.064
Total	0.230	0.106	0.336
1961			
First quarter	0.064	0.028	0.092
Second quarter	0.082	0.030	0.112
Third quarter	0.045	0.027	0.072
Fourth quarter	0.124	0.062	0.186
Total	0.315	0.147	0.462

TABLE 4.—RATIOS OF STRONTIUM-89 TO STRONTIUM-90 IN FALLOUT AT MIDPOINTS OF LATITUDE COLLECTION BANDS—1961

Period	80-50°N	50-40°N	40-30°N	30-20°N	20-10°N	10°N-0	0-10°S	10-20°S	20-30°S	30-40°S	40-50°S
September	45	53	25	31	10	19	10	<1	<1	<1	<1
October	50	74	70	54	71	15	5	<1	<1	<1	<1
November	60	77	78	69	65	81	44	<1	<1	<1	<1
December	49	56	50	60	58	61	58	<1	<1	<1	<1

Analyses for strontium–89 were carried out on samples collected during the last four months of 1961 and the monthly average Sr^{89}/Sr^{90} ratios for the latitude bands under consideration are given in table 4. Since strontium–89 was not detected in any samples collected below 10° south latitude, it can be concluded that no pronounced effects from the 1961 fall testing occurred below this latitude. A steady increase in strontium–90 deposition was observed (see table 1) from October through December at sites north of 10° south latitude whereas the deposition rate for sites below this latitude either fluctuated or remained steady. It is quite evident that massive trans-equatorial movement of polar debris had not occurred during the fall of 1961.

From the strontium–89 deposition, it is possible to estimate the contribution to the total strontium–90 deposition rates after the 1961 tests. October 18, 1961 was assumed to be representative of the date of origin of debris deposited in the northern hemisphere during November and December 1961. Using a theoretical Sr^{89}/Sr^{90} ratio at production of 146 (*10*), it was calculated that between 70 and 75 percent of the northern hemisphere strontium–90 fallout in November originated from the U.S.S.R. tests. In December 1961, the U.S.S.R. contribution was about 85 per cent.

The present estimate reveals that about 0.46 megacuries of strontium–90 were deposited in 1961 within those latitude bands covered by the sampling network compared to 0.34 megacuries deposited in 1960 (table 3). The northern hemisphere received about twice as much fallout in 1960 and 1961 as the southern hemisphere. This difference is expected to be substantially larger in 1962.

Had nuclear testing not been resumed in the fall of 1961, the total strontium–90 deposition in the northern hemisphere for that year would probably have been about the same as it was in 1960. Furthermore, the trend towards equalization of annual fallout rates between the northern and southern hemispheres would most likely have continued.

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SECTION II.—FOOD

Tri-City Diet Study*

April 1962

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Since May 1960 the Health and Safety Laboratory, through its quarterly diet study, has made estimates of the strontium–90 content of the average diet of individuals living in New York City, San Francisco, and Chicago.

Selected foods, representing 19 food categories, are purchased at each of these 3 cities about every 3 months and are analyzed for strontium–90. Using data from the U.S. Department of Agriculture "Household Food Survey of 1955," the annual consumption by an average individual can be grouped into the same 19 food categories. The annual dietary intake of strontium–90 can then be estimated by summing the contributions from each category. Some food types are assumed to be representative of larger food categories, such as liquid milk for dairy products in general.

The consumption data from the "Household Food Survey of 1955" are based on a weight-as-purchased basis. Before the food samples for the Tri-City Diet Study are ashed for radiochemical analysis, they are prepared to a certain degree, as if for actual consumption. For example, fruits are peeled, eggs are shelled, and poultry is de-boned. Therefore, concentrations of radioactivity in foods as reported in the Tri-City Diet Study are based on analyses of the trimmed portions of foods.

Results obtained from the eighth sampling of foods (April 1962) are presented in table 1. The variation with time of the daily intake of strontium–90 in the 3 cities is plotted in figure 1.

Because of the resumption of atmospheric tests of nuclear weapons by the U.S.S.R. in the fall of 1961, it was possible to ascertain what foods were most quickly contaminated with fresh fallout by analyzing the foods for the relatively short-lived fission product strontium–89 (half-life = 51 days).

Significant levels of strontium–89 were found in milk, fresh vegetables, and potatoes. From the observed Sr^{89}/Sr^{90} ratios in the foods, and from an estimate of the Sr^{89}/Sr^{90} ratio for fallout coming exclusively from the U.S.S.R. test series, it was possible to make a crude estimate of the fraction of strontium–90 from this test series found in the food.

These estimates indicate that about 80 percent of the strontium–90 detected in milk in San Francisco probably came from the U.S.S.R. tests. About 60 percent of the strontium–90 in milk from New York City and about 10 percent of the strontium–90 in milk from Chicago was due to fresh fallout.

The previously noted geographic pattern of distribution of strontium–90 in foods is seen to persist in the last sampling. New York City has the highest levels, while Chicago has intermediate levels. Milk continues to be the predominant source of strontium–90 in the diet. This is partly due to its high annual consumption.

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[*] U.S. Atomic Energy Commission: *Fallout Program Quarterly Summary Report, HASL–131*:235–8, Office of Technical Services, Department of Commerce, Washington 25, D.C. (October 1, 1962), price $3.50.

TABLE 1.—AVERAGE PERSON DIETARY CONSUMPTION AND STRONTIUM-90 INTAKE—EIGHTH SAMPLING

Food Category	Average U. S. Consumption		New York City April 1962		Chicago April 1962		San Francisco April 1962	
	Food (kg/yr)	Calcium (g/yr)	(μμc/kg)	(μμc/yr)	(μμc/kg)	(μμc/yr)	(μμc/kg)	(μμc/yr)
Bakery products	37	37.0	2.8	104	6.5	241	5.1	188
Whole grain products	11	10.0	7.7	85	10.4	114	6.2	68
Eggs	16	9.1	1.5	24	2.4	38	0.1	2
Vegetables, fresh	43	15.0	5.5	237	9.1	389	1.3	57
Vegetables, root	17	6.1	4.4	75	5.8	98	2.7	46
Milk	221	234.2	9.3	2,044	4.8	1,056	5.2	1,151
Poultry	17	9.2	0.8	14	1.0	16	0.8	13
Fish, fresh	8	10.8	0.4	3	0.7	6	0.9	7
Flour	43	8.6	4.5	194	4.8	207	2.1	90
Macaroni	3	0.7	3.2	10	4.1	12	3.2	10
Rice	3	1.1	2.3	7	1.8	5	1.5	5
Meat	73	10.9	1.6	117	1.4	105		[a] 36
Fish, shell	1	0.8	8.2	8	1.3	1	0.7	0
Beans, dried	3	2.9	10.3	31	10.8	32	2.4	7
Fruit, fresh	68	13.6	8.8	598	7.6	515	1.5	99
Potatoes	45	5.8	3.8	171	2.1	131	1.6	72
Fruit, canned	26	1.3	1.2	31	1.2	30	0.5	13
Juices, fruit	19	1.7	3.8	72	1.9	37	2.7	51
Vegetables, canned	20	4.2	3.7	74	5.3	106	1.3	25
Annual intake	674	383	5.8	3,899	4.7	3,139	2.9	1,940
Strontium-90 to calcium ratio in total diet			10.2 (μμc Sr^{90}/g Ca)		8.2 (μμc Sr^{90}/g Ca)		5.1 (μμc Sr^{90}/g Ca)	

[a] Estimated from seventh sampling.

Not only is the total intake of strontium-90 of interest but also the strontium-90 to calcium ratio, Sr^{90}/g Ca, expressed as μμc strontium-90 per gram calcium. [*Editor's note: The Sr^{90}/g Ca ratio may be thought of as the amount of strontium-90 existing in a material per unit of calcium existing in the same material. From a given foodstuff, a certain amount of calcium is retained in the body, and the amount of strontium-90 which coexists with the calcium in this foodstuff is a determining factor in how much strontium-90 is deposited.*] These ratios for the total diet are shown in table 1.

The Sr^{90}/g Ca ratios in milk have been used to estimate the Sr^{90}/g Ca ratios in the total diet. The validity of this use of the Sr^{90}/g Ca ratio in milk as an indicator for the Sr^{90}/g Ca in the total diet may depend on the nature and rate of fallout. The ratio of the Sr^{90}/g Ca ratio in the total diet to the Sr^{90}/g Ca ratio in the milk was 1.1, 1.7, and 1.0 for New York, Chicago, and San Francisco, respectively, in April. Values obtained previously have ranged from 1.0 to 2.0. There seems to be a tendency, as exemplified in the last sampling, for the ratio to be lower during periods of higher fallout rates than during periods of lower fallout rates. Expressed differently, during periods with greater fallout rates, a greater percentage increase of the Sr^{90}/g Ca ratio occurs in milk than in other foods. If this is true, then a reasonable estimate of total diet Sr^{90}/g Ca ratio made by multiplying the milk Sr^{90}/g Ca ratio by a factor of 1.5 would be on the conservative side during periods of heavy fallout, since the use of this factor would overestimate the Sr^{90}/g Ca ratio in the total diet.

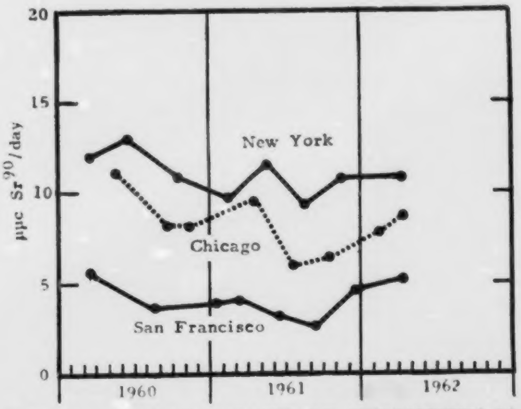

FIGURE 1.—DAILY INTAKE OF STRONTIUM-90 IN TRI-CITY TOTAL DIETS

Previous coverage in *Radiological Health Data:*

Period	Issue
Third sampling (October 1960–January 1961)	*October 1961*
Fourth sampling (February–April 1961)	*December 1961*
Fifth sampling (May–July 1961)	*March 1962*
Sixth sampling (August–October 1961)	*June 1962*
Seventh sampling (November 1961–February 1962)	*September 1962*

Editor's note: A necessary step in determining the dietary intake of radioactivity is the securing of information on kinds and amounts of food consumed by the population of the United States. Because of the importance of whole milk, particularly in the diet of infants and children, recently obtained milk consumption data from a national survey are published below.

National Food Consumption Survey

FRESH WHOLE MILK CONSUMPTION IN THE UNITED STATES
July 1962

Bureau of the Census, Department of Commerce and Division of Radiological Health, Public Health Service

The data below on whole milk consumption in July 1962 are the first available from the National Food Consumption Survey being conducted by the Bureau of the Census on behalf of the Public Health Service. Additional material showing the mean food consumption values and associated errors is now being prepared for milk and for four other selected food items (beef, white sliced bread, lettuce, and apples). These data were obtained in the July test of this survey. During the first two weeks of each quarter, beginning July 1962, a representative sample of the U.S. population is being surveyed to provide estimates of the amounts and kinds of food consumed. The survey is being conducted with the support of the Division of Radiological Health (DRH), and the Heart Disease Control Program (HDCP), Division of Chronic Diseases of the PHS.

The survey was designed initially to develop the methods and procedures for the collection of data related to individual consumption of selected food items. In subsequent months similar information will be gathered by the survey procedure on additional selected food items and components of the total diet.

Consumption estimates from this survey will be related to personal characteristics such as age and sex, region of residence, and socioeconomic characteristics. This survey is now a component of the Census Bureau's Quarterly Household Survey.

Use in Dietary Intake Estimates

Plans are to combine food consumption estimates obtained from the survey with radiation concentration data collected in the Division of Radiological Health's National Dietary Assessment Program to produce estimates of radionuclide intake from the diet. It is intended that these data will provide an empirical basis for establishing or revising radiation exposure guides and standards for this source. Also, the program is designed to determine the feasibility of using an "indicator food list" for the surveillance and assessment of radionuclide intake.

Design of Survey

In July the Food Consumption Survey was conducted in 333 primary sampling units located in every State and the District of Columbia. This sample contained a total of approximately 11,500 housing units (both occupied and vacant) and completed interviews were obtained in approximately 8,900 of these, containing about 28,000 persons.

In the initial phase of the survey, two experimental techniques were used. First, in one systematic subsample, a three-day recall personal interview was used as a collection device. In another subsample, a one-day recall interview was conducted and the respondent was asked to maintain a diary for a three-day period. In about one-third of the latter group, the interviewer returned after the record period to pick up and review the diary; in the remaining two-thirds, the respondent was asked to mail the completed diary. This was done to measure differences in response rates and quality of response. Since all of these procedures utilized probability samples, the results may be compared directly. One limitation of the procedure was that it was not feasible (because of other commitments in the Census survey) to randomize the interviews by day of the week. To the extent that consumption patterns vary significantly by day of the week, additional errors may be introduced. The figures shown in table 1 are based only on the results of the personal interviews—both the three-day recall and the one-day recall; final results of the diary approach as yet are not available. Examination of preliminary data obtained by diary, however, indicates no substantial differences.

Survey Results

Table 1 shows the percentage distribution of the amounts of whole milk consumed at home on an average day for the civilian non-institutional population of the United States. These estimates by age and sex and consumption categories are limited to fresh whole milk consumed *at home* and are based on a survey conducted during the first two weeks of July 1962. The number of observations indicate the person-days associated with each age and sex grouping.

While the table is self-explanatory, some items appear worthy of note. On an average

TABLE 1.—DAILY PERCENTAGE* DISTRIBUTION OF "AT HOME" CONSUMPTION OF WHOLE MILK BY AGE AND SEX—JULY 1962

Age	Number of observations	Amount of milk consumed (fluid ounces)											
		0	1-3	4-7	8-11	12-15	16-19	20-23	24-27	28-31	32-35	36-39	40 or more
MALE													
All ages	32,012	32.1	5.7	7.8	11.6	5.9	10.0	4.2	7.6	2.7	6.8	1.3	4.2
Under 1	713	38.0	0.1	1.9	1.4	2.7	4.1	4.2	10.7	5.3	20.4	1.3	9.9
1-4	3,073	15.9	1.6	5.1	8.9	10.4	14.2	7.6	14.5	4.7	11.0	1.9	4.3
5-9	3,744	20.5	1.3	5.3	10.2	8.3	12.9	7.1	15.1	4.7	8.6	1.8	4.2
10-14	3,577	25.0	1.4	4.6	8.6	6.8	10.3	6.7	11.3	5.2	10.2	1.7	8.1
15-19	2,592	28.9	2.6	4.9	8.8	5.7	9.3	4.1	9.1	3.0	10.0	3.0	10.5
20-24	1,678	35.1	4.1	6.7	14.7	4.4	10.8	3.4	4.6	2.3	6.9	1.5	5.3
25-29	1,614	39.1	7.5	7.6	11.0	5.8	10.5	1.7	6.2	2.2	4.5	0.6	3.2
30-34	1,976	37.5	9.8	9.1	14.4	5.7	8.0	3.2	4.6	1.1	4.5	0.4	1.7
35-44	4,233	39.1	10.4	9.4	13.4	4.6	8.5	2.8	4.0	1.2	4.0	0.8	1.7
45-54	3,567	42.0	9.5	11.0	13.7	4.4	7.1	1.9	2.8	1.1	3.4	0.5	2.5
55-64	2,584	40.9	8.4	11.2	13.2	4.1	9.5	2.5	2.8	1.1	3.7	0.8	2.4
65 and over	2,661	35.4	8.2	12.8	15.8	4.5	10.1	2.5	3.5	1.2	4.0	0.6	1.5
FEMALE													
All ages	33,568	37.9	6.8	9.9	13.1	6.3	9.0	3.4	5.6	1.6	4.1	0.6	1.6
Under 1	747	41.2	0.5	1.1	3.2	2.3	4.5	3.4	9.6	5.7	20.5	1.5	6.5
1-4	2,890	17.3	1.1	7.2	10.2	11.1	12.0	7.0	12.6	4.1	10.9	1.7	3.9
5-9	3,536	23.6	1.6	6.9	11.5	9.9	13.9	7.2	11.5	2.9	6.8	1.2	3.0
10-14	3,399	32.3	2.1	5.6	12.3	7.1	11.2	6.3	10.3	3.1	5.4	1.4	2.8
15-19	2,661	39.4	4.0	6.4	13.0	6.3	10.1	4.1	7.2	1.7	5.1	0.6	2.1
20-24	1,984	42.8	6.6	7.9	17.2	6.5	7.8	2.3	4.6	1.1	2.1	0.3	0.9
25-29	1,807	43.1	10.2	9.9	14.6	5.0	8.2	1.5	2.6	1.3	2.1	0.6	0.8
30-34	2,094	43.9	12.3	11.7	14.7	4.3	7.0	1.2	2.3	0.9	1.0	0.2	0.5
35-44	4,674	45.3	11.8	12.5	12.2	5.0	6.7	1.6	2.5	0.5	1.5	0.1	0.4
45-54	3,695	46.2	9.9	12.3	15.6	4.3	6.0	1.8	1.6	0.2	1.5	0.2	0.3
55-64	2,840	45.1	9.3	14.0	13.1	4.9	7.2	1.0	2.2	0.5	1.7	0.2	0.7
65 and over	3,241	39.6	8.2	15.2	15.1	5.2	9.5	1.5	2.4	0.0	2.4	0.2	0.8

* Percentages based on number of "person observations."

day during the period over one-third of the *total* population reported no fresh, whole, white milk consumption at home. At the other end of the scale 12.3 percent of the males and 6.3 percent of the females reported a daily consumption of one quart or more. In the age group *under one* these extremes are even more striking; namely, approximately 40 percent reported no milk consumption in this form while approximately 30 percent reported consumption of a quart or more. These observations on the under one year of age group may be explained by the fact that the survey did not include breast and formula milk consumption, which would be an important factor for infants.

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Teen-Ager Diet Survey
May 1961–August 1962

Division of Pharmacology, Food and Drug Administration

It has been estimated that among all age groups the 19–year–old male consumes more food daily than any other segment of the United States population (*1*). Using this information, the Food and Drug Administration is surveying the foods consumed by this particular teenage group as a method for conservatively estimating the radionuclide intake of other population groups.

The Food and Drug Administration's Teenage Diet Survey was begun on a pilot basis in May 1961, in the Washington, D.C. area. Since then the program has been expanded to include four other cities: San Francisco, Minneapolis, St. Louis, and Atlanta.

By selecting the 19–year–old male, who consumes 3.76 kilograms (about 8 pounds) of food per day as compared with the "standard man" who averages 2.2 kilograms (about 5 pounds) per day, the radionuclide intake in the average total diet can be conservatively estimated. For the purposes of the sampling program, total diet is defined as all food and drink consumed daily by the 19–year–old male living in a moderate income family. The composition of the diet as well as the proportions of its constituents are based on the 1955 survey of the United States Department of Agriculture (*1*).

Procedures

To duplicate the diet of a 19–year–old male, a list of 82 different items of food and drink was prepared. The amounts of these items, covering a two-week consumption period, were purchased from national food chains.

Four food chains were sampled, but the variation of radionuclide concentration in a particular food was found to be statistically insignificant. Every effort was made to locate the source of the food items and arrange representation in the sample on as broad a geographical basis as possible.

The food was prepared by professional dietitians at the National Institutes of Health in a manner comparable to domestic preparation procedure. All edible parts of the total diet (including drinking water) were homogenized into a slurry, and aliquots were analyzed for strontium–90 and cesium–137.

In addition to analyses of the total diet, the major constituent categories of the diet were also analyzed in order to identify the radionuclide contribution of each. The 11 categories and the separate food items they contain are as follows:

Dairy:	Fresh and processed milk, ice cream, cheese, butter, margarine.
Grain:	Flour, pancake mix, corn flakes, wheat cereal, rice flakes, puffed rice, rice, oatmeal, corn meal, macaroni, wheat bread, saltines, cookies, crackers, rolls, pie crust, cake, pudding mix, shredded wheat, grits.
Leafy vegetables:	Cauliflower, spinach, broccoli, celery, lettuce, cabbage, asparagus, mustard.
Smooth vegetables:	Cucumbers, peas, green beans, corn, mushrooms, summer squash, rhubarb, lima beans, green peppers.
Root vegetables:	Carrots, onions, beets, rutabagas, turnips.
Potatoes:	White potatoes, potato chips.
Dried beans:	Canned beans with pork, peanut butter, dried beans with pork.
Fruits:	Tomatoes, catchup, oranges, orange juice, bananas, raisins, peaches, apples, strawberries, cherries, pears, vinegar, grapes, watermelon, apricots.
Meat, eggs:	Beef, pork chops, pork sausage, bacon, chicken, fish, luncheon meat, frankfurt, beef liver, eggs.
Sugar, fats, oils:	Salad dressing, mayonnaise, shortening, sugar, jelly, syrup, molasses, candy.
Beverages: (excluding drinking water)	Tea, coffee, cocoa, soft drinks.

Inedible portions contained in foods were analyzed for the Washington, D.C. area only.

The dietary values for strontium–90 shown in table 1 cannot be directly compared with those shown in tables 2 and 3. This is due to (1) differences in the compositing procedures (inclusion or exclusion of drinking water) and (2) analytical limitations.

TABLE 1.—DISTRICT OF COLUMBIA AND METROPOLITAN AREA TOTAL DIET SURVEY, 19-YEAR-OLD MALE STRONTIUM-90 INTAKE FROM THE CONSTITUENTS OF THE DIET OVER 14-DAY PERIODS IN MONTHS SHOWN

Diet items	Weight of Food Consumed		Strontium-90 in Food Consumed		Concentration of Strontium-90
	kg	percent	pc	percent	pc/kg
May 1961					
Dairy	12.090	26.7	85	50.3	7.0
Grain	6.780	15.0	20	11.9	2.9
Vegetables, leafy	1.238	2.74	3.5	2.07	2.8
Vegetables, smooth	1.340	2.96	4.3	2.55	3.2
Vegetables, root	0.666	1.48	1.6	0.95	2.4
Potatoes	3.169	7.00	7.7	4.55	2.4
Beans, dried	0.822	1.81	9.5	5.62	12
Fruits	5.510	12.2	11	6.51	2.1
Meat, eggs	3.421	7.56	16	9.24	4.6
Sugar, fats, oils	1.206	2.67	7.3	4.32	6.1
Beverages	9.048	20.0	3.4	2.02	0.4
Total	45.290	100.1	169	100.0	3.7
August 1961					
Dairy	12.472	28.4	114	61.6	9.2
Grain	5.816	13.2	18	9.90	3.2
Vegetables, leafy	1.098	2.50	2.7	1.45	2.5
Vegetables, smooth	1.246	2.84	6.2	3.34	5.0
Vegetables, root	0.917	2.09	2.3	1.24	2.5
Potatoes	2.598	5.92	5.7	3.07	2.2
Beans, dried	0.822	1.87	9.0	4.84	11
Fruits	4.825	11.0	7.0	3.77	1.5
Meat, eggs	3.657	8.33	11	6.08	3.1
Sugar, fats, oils	1.419	3.23	3.5	1.88	2.5
Beverages	9.048	20.6	5.5	2.96	0.6
Total	43.918	100.0	185.0	100.1	4.2
November 1961					
Dairy	12.186	27.4	92	48.6	7.5
Grain	5.943	13.4	24	12.7	4.0
Vegetables, leafy	1.119	2.52	3.1	1.64	2.7
Vegetables, smooth	0.932	2.10	6.4	3.36	6.9
Vegetables, root	0.799	1.80	2.3	1.22	2.9
Potatoes	2.858	6.43	5.4	2.85	1.9
Beans, dried	0.822	1.85	9.7	5.13	12
Fruits	5.590	12.6	15	8.13	2.8
Meat, eggs	3.762	8.46	20	10.4	5.2
Sugar, fats, oils	1.504	3.38	1.5	0.74	1.0
Beverages	9.048	20.4	9.7	5.13	1.1
Total	44.653	100.3	189	99.9	4.2

TABLE 1.—DISTRICT OF COLUMBIA AND METROPOLITAN AREA TOTAL DIET SURVEY, 19-YEAR-OLD MALE STRONTIUM-90 INTAKE FROM THE CONSTITUENTS OF THE DIET OVER 14-DAY PERIODS IN MONTHS SHOWN—(Continued)

Diet items	Weight of Food Consumed		Strontium-90 in Food Consumed		Concentration of Strontium-90
	kg	percent	pc	percent	pc/kg
February 1962					
Dairy	12.035	27.5	148	55.4	12
Grain	5.940	13.6	37.5	14.1	6.3
Vegetables, leafy	1.368	3.12	3.4	1.27	2.5
Vegetables, smooth	1.717	3.92	7.8	2.91	4.5
Vegetables, root	0.523	1.19	1.1	0.41	2.1
Potatoes	2.805	6.41	4.0	1.49	1.4
Beans, dried	0.822	1.88	9.1	3.41	11
Fruits	4.601	10.5	9.2	3.45	2.0
Meat, eggs	3.494	7.98	17.5	6.54	5.0
Sugar, fats, oils	1.431	3.27	6.0	2.25	4.2
Beverages	9.048	20.7	23.6	8.85	2.6
Total	43.784	100.1	267	100.1	6.1
May 1962					
Dairy	12.200	27.5	215	62.7	18
Grain	6.078	13.7	60	17.5	9.9
Vegetables, leafy	1.160	2.61	7.4	2.16	6.5
Vegetables, smooth	1.342	3.04	4.6	1.34	3.4
Vegetables, root	0.598	1.35	4.3	1.25	7.2
Potatoes	2.612	5.88	5.9	1.72	2.3
Beans, dried	0.820	1.85	8.2	2.39	10
Fruits	5.362	12.1	11	3.62	2.1
Meat, eggs	3.644	8.2	14	4.05	3.8
Sugar, fats, oils	1.522	3.43	4.6	1.34	3.1
Beverages	9.049	20.4	9.0	2.62	0.3
Total	44.387	100.1	344	100.7	7.8
August 1962					
Dairy	12.017	27.8	370	67	31
Grain	6.886	14.8	60	10.9	9.4
Vegetables, leafy	0.939	2.18	7.7	1.39	8.2
Vegetables, smooth	1.403	3.25	20	3.62	14
Vegetables, root	0.618	1.43	6.2	1.12	10
Potatoes	2.565	5.94	18	3.26	7.0
Beans, dried	0.822	1.90	11	1.99	13
Fruits	3.981	9.22	18	3.26	4.5
Meat, eggs	3.709	8.59	12	2.17	3.2
Sugar, fats, oils	1.407	3.26	6.6	1.20	4.7
Beverages	9.318	21.6	22	3.99	2.4
Total	43.665	100.0	552	99.9	12.6

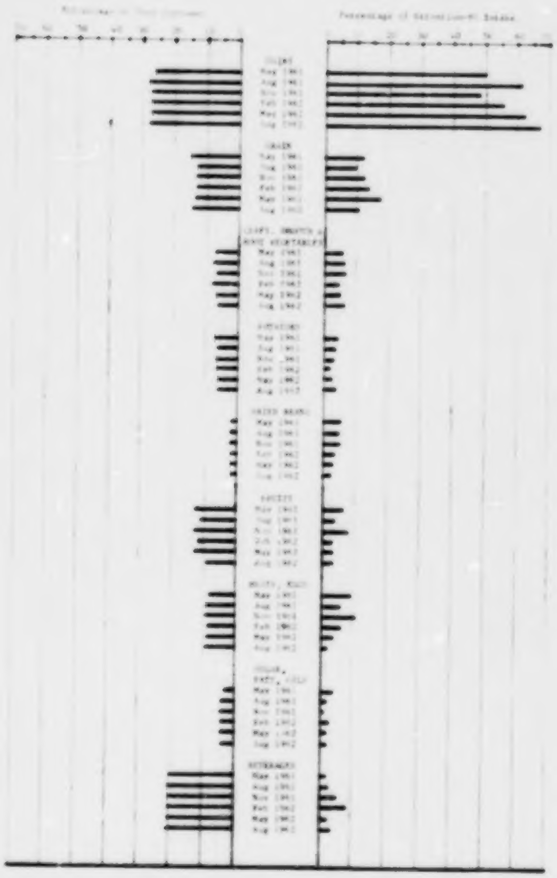

FIGURE 1.—PERCENTAGE FOOD CONSUMPTION AND PERCENTAGE STRONTIUM-90 INTAKE FROM THE CONSTITUENTS OF THE DIET (EXCLUDING DRINKING WATER) FOR WASHINGTON, D.C.

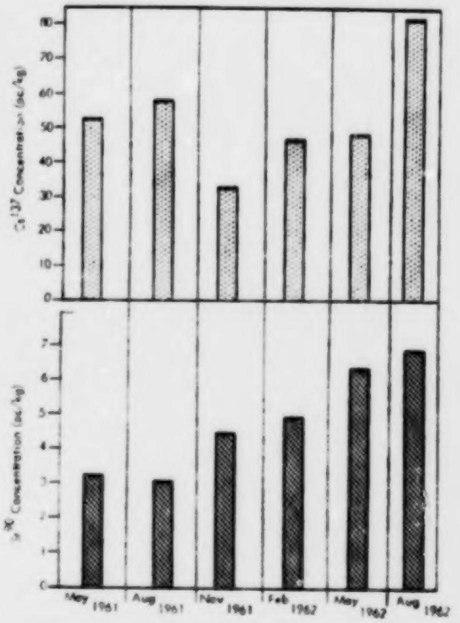

FIGURE 2.—STRONTIUM-90 AND CESIUM-137 CONCENTRATIONS IN THE TOTAL DIET (INCLUDING DRINKING WATER) FOR WASHINGTON, D.C.

Results

Table 1 presents the data for Washington, D.C. by food category from May 1961 through August 1962. Figure 1 shows percentages of the total diet by weight and percentages of the strontium-90 intake contributed by each of the 11 food categories from May 1961 through August 1962 for Washington, D.C.

Figure 2 compares for Washington, D.C. the strontium-90 and cesium-137 concentration in the total diet. No correlation between the two is immediately apparent. Table 2 displays the distribution of strontium-90 in the waste and edible portions for Washington, D.C. Strontium-90 and cesium-137 concentrations in the total diet for the various cities covering the period May 1962 through August 1962 are given in table 3.

Summary

The important observation is that dairy products, together with food items originating from grains, contribute 60 to 80 percent of the strontium-90 intake. This indicates that when one is concerned about surveillance on a nationwide scale of the intake of strontium-90

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Table 2.—DISTRIBUTION OF STRONTIUM-90 IN WASTE AND EDIBLE PARTS OF THE TOTAL DIET (INCLUDING DRINKING WATER)

Date	Waste				Edible Food
	Edible	Inedible	Bone	Cooking water	
May 1961 (pc)	1.7	22	156	1.3	167
August 1961 (pc)	1.6	24	174	1.6	163
November 1961 (pc)	9.3	26	125	2.0	219
February 1962 (pc)	8.0	40	261	5.5	261
Average weight of constituents (kg)	0.688	1.425	0.302	0.909	52.628

Table 3.—STRONTIUM-90 CONCENTRATIONS IN THE TOTAL DIET (INCLUDING DRINKING WATER)

[pc/kg]

City		May 1962	August 1962
D. C:	Washington	6.4	6.9
Ga:	Atlanta	9.5	5.2
Calif:	San Francisco	3.0	3.4
Minn:	Minneapolis	4.0	8.4
Mo:	St. Louis	10	8.3

due to fallout, an estimate can be made concerning the average strontium-90 intake of an average individual by examining the strontium-90 contents of grains and dairy products. However, limited studies of the total diet would be useful in checking the above observation in every decade.

REFERENCE

(*1*) U.S. Department of Agriculture: *Food Consumption of Households in the United States, Report No. 1*, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (1955), price $1.25.

SECTION III.—MILK

Milk Surveillance

PASTEURIZED MILK NETWORK
September 1962

Division of Radiological Health and
Division of Environmental Engineering and Food Protection, Public Health Service

In recognition of the importance of milk as a dietary component, the Public Health Service conducts a continuous monitoring program for radionuclides in pasteurized milk. Milk lends itself readily to a national sampling program because of its widespread and continuous availability and its ease of preparation and analysis compared to other foods.

In 1957, the PHS initiated the investigation of raw milk to determine relationships between dairy practices and radionuclide levels in milk. However, it became evident that the milk actually consumed by the population should be included in a broader sampling program. In 1960, the pasteurized milk network was initiated to provide data representative of the milk consumed in selected municipalities. Both raw and pasteurized milk sampling data were reported concurrently until June 1961 to permit comparison of the differences between the earlier, limited, milkshed sampling results and those exhibited in pasteurized milk monitoring. Since June 1961, raw milk sampling has been carried out for investigative rather than monitoring purposes.

During September 1962, pasteurized milk surveillance was conducted at 62 Pasteurized Milk Network stations with the cooperation of State and local milk sanitation agencies which have been shipping samples to the PHS Southwestern, Southeastern, and Northeastern Radiological Health Laboratories for analysis. Publication in *Radiological Health Data* follows 3 to 4 months after sample collection because of the time required for shipment, processing, radio-analysis of strontium, data compilation, and publication procedures.

Sampling and Compositing Procedures

The current program emphasizes (1) measurement of the concentrations of radioactivity in samples of pasteurized milk consumed by the public in various regions of the country, and (2) provision of at least one sampling point within virtually all States and additional points when indicated by widely varying conditions of the milk supply or when needed in order to cover large population groups. Each sample is composited from subsamples collected from each plant in proportion to the relative volumes of milk sold. The objective of this sampling program is to reflect at least 90 percent of each city's milk supply. Prior to September 15, 1961, the composite sample was taken from one day's sales per month and was as representative of a community's total supply as could be achieved under practical conditions. Since the resumption of nuclear weapons testing, the sampling schedule has been increased in frequency. During September 1962, most stations

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were sampled twice a week. All surveillance data are subject to continuing review and evaluation to observe unusual patterns or concentrations which may require immediate attention. Further atmospheric nuclear testing may require re-evaluation and adjustment of the sampling frequency and analytical schedule for this program.

Iodine–131, cesium–137, and barium–140 are determined by gamma scintillation spectroscopy,[1] while strontium–89 and strontium–90

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[1] Southeastern Radiological Health Laboratory employs a radiochemical procedure for barium–140 analysis.

TABLE 1.—RADIOACTIVITY IN PASTEURIZED MILK, SEPTEMBER 1962

[Average radioactivity concentrations in $\mu\mu$c/liter]

Sampling locations	Calcium (g/liter)		Strontium–89		Strontium–90		Iodine–131		Cesium–137		Barium–104		Sr^{90} profile in RHD
	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	
Ala: Montgomery	1.22	1.24	35	20	13	12	10	20	35	35	10	<10	Oct. 1962
Alaska: Palmer	1.08	1.17	75	175	12	14	250	730	55	80	30	90	Nov. 1962
Ariz: Phoenix	1.08	1.11	10	<5	2	2	10	10	15	10	10	<10	Jan. 1963
Ark: Little Rock	1.21	1.24	80	55	29	27	10	20	55	50	20	20	Nov. 1962
Calif: Sacramento	1.11	1.18	5	<5	3	2	20	<10	20	10	20	<10	Dec. 1962
San Francisco	1.13	1.18	10	10	4	3	20	20	20	10	20	20	Oct. 1962
Colo: Denver	1.11	1.13	55	45	15	12	30	20	75	60	10	10	Dec. 1962
Conn: Hartford	1.10	1.12	30	35	12	13	30	70	70	55	<10	<10	Dec. 1962
Del: Wilmington	1.09	1.11	40	55	13	14	30	70	70	55	<10	<10	Jan. 1963
D.C: Washington	1.16	1.18	45	30	17	18	20	60	60	55	10	10	Oct. 1962
Fla: Tampa	1.23	1.25	20	20	11	12	<10	<10	145	140	<10	<10	Jan. 1963
Ga: Atlanta	1.23	1.23	45	35	19	17	20	10	55	50	10	<10	Sep. 1962
Hawaii: Honolulu	1.07	1.15	10	10	4	3	10	10	35	30	<10	<10	Nov. 1962
Idaho: Idaho Falls	1.09	1.15	45	30	11	11	40	40	75	60	20	20	Jan. 1963
Ill: Chicago	1.14	1.17	35	40	14	15	50	100	60	50	<10	10	Oct. 1962
Ind: Indianapolis	1.11	1.10	40	45	16	21	30	70	40	30	<10	<10	Dec. 1962
Iowa: Des Moines	1.10	1.18	80	65	14	13	60	120	40	35	20	20	Jan. 1963
Kans: Wichita	1.12	1.17	60	45	13	12	40	30	40	35	10	<10	Nov. 1962
Ky: Louisville	1.19	1.23	75	55	22	24	20	40	35	30	20	20	Jan. 1963
La: New Orleans	1.22	1.24	75	55	30	28	10	<10	80	70	20	10	Nov. 1962
Maine: Portland	1.15	1.10	45	60	15	14	30	60	120	105	<10	<10	Jan. 1963
Md: Baltimore	1.16	1.19	40	35	18	18	20	60	60	60	<10	10	Jan. 1963
Mass: Boston	1.12	1.11	45	50	21	25	30	70	125	105	10	20	Oct. 1962
Mich: Detroit	1.10	1.12	35	50	12	11	50	120	70	55	<10	10	Dec. 1962
Grand Rapids	1.15	1.14	35	45	10	9	40	70	60	55	<10	<10	Jan. 1963
Minn: Minneapolis	1.10	1.16	85	85	21	19	40	100	[illegible]	90	20	30	Oct. 1962
Miss: Jackson	1.26	1.27	70	45	21	18	10	<10	45	35	20	<10	Dec. 1962
Mo: Kansas City	1.07	1.14	80	55	14	13	50	60	35	30	20	20	Dec. 1962
St. Louis	1.08	1.17	60	40	16	12	40	50	40	35	20	20	Nov. 1962
Mont: Helena	1.14	1.20	80	55	15	17	50	90	85	85	20	20	Nov. 1962
Nebr: Omaha	1.12	1.20	85	60	14	14	60	80	50	50	20	20	Jan. 1963
Nev: Las Vegas *	1.06	1.10	25	35	5	5	30	20	35	20	<10	<10	*
N.H: Manchester	1.13	1.12	45	65	17	17	30	60	145	115	<10	10	Jan. 1963
N.J: Trenton	1.12	1.13	35	45	12	18	20	50	65	60	<10	10	Dec. 1962
N. Mex: Albuquerque	1.10	1.17	20	15	5	4	30	20	25	15	10	<10	Nov. 1962
N.Y: Buffalo	1.10	1.10	35	55	15	14	40	100	70	65	<10	10	Dec. 1962
New York	1.08	1.14	40	45	16	20	40	90	80	70	<10	10	Oct. 1962
Syracuse	1.11	1.10	40	60	12	15	40	90	60	50	10	20	Nov. 1962
N.C: Charlotte	1.23	1.26	55	40	23	20	<10	<10	50	45	10	10	Nov. 1962
N.D: Minot	1.11	1.15	100	80	22	19	80	170	80	75	20	30	Jan. 1963
Ohio: Cincinnati	1.12	1.13	45	55	13	12	40	80	40	30	<10	<10	Dec. 1962
Cleveland	1.11	1.12	30	35	14	16	40	90	55	50	<10	10	Nov. 1962
Okla: Oklahoma City	1.16	1.20	60	35	17	18	20	20	45	40	10	10	Oct. 1962
Ore: Portland	1.12	1.22	60	25	12	11	20	30	65	55	10	10	Dec. 1962
Pa: Philadelphia	1.14	1.15	30	35	14	17	30	60	70	65	<10	<10	Nov. 1962
Pittsburgh	1.12	1.12	40	45	18	19	30	70	85	70	<10	10	Nov. 1962
P.R: San Juan	1.19	1.20	25	20	11	10	<10	<10	35	30	10	<10	Nov. 1962
R.I: Providence	1.11	1.09	35	40	13	14	20	50	85	80	<10	10	Jan. 1963
S.C: Charleston	1.21	1.24	45	25	20	20	10	10	65	65	<10	<10	Dec. 1962
S.D: Rapid City	1.06	1.12	85	55	20	14	70	130	60	65	20	20	Oct. 1962
Tenn: Chattanooga	1.25	1.28	65	40	23	19	10	20	55	45	10	10	Oct. 1962
Memphis	1.22	1.23	60	40	21	20	10	20	25	25	20	20	Jan. 1963
Tex. Austin	1.16	1.16	15	10	6	5	<10	<10	20	15	<10	<10	Oct. 1962
Dallas	1.18	1.19	40	25	14	12	10	<10	30	25	<10	<10	Dec. 1962
Utah: Salt Lake City	1.10	1.19	60	35	12	10	320	40	95	60	40	20	Nov. 1962
Vt: Burlington	1.10	1.12	45	65	14	17	20	60	110	105	<10	10	Dec. 1962
Va: Norfolk	1.20	1.24	55	35	22	21	10	20	75	55	<10	<10	Dec. 1962
Wash: Seattle	1.10	1.18	45	45	15	18	30	30	90	75	20	20	Oct. 1962
Spokane	1.15	1.18	40	30	14	12	50	60	70	65	10	10	Dec. 1962
W. Va: Charleston	1.16	1.19	80	50	24	21	20	30	45	35	10	10	Oct. 1962
Wis: Milwaukee	1.10	1.12	30	40	9	8	50	120	60	50	<10	<10	Jan. 1963
Wyo: Laramie	1.11	1.18	125	95	15	13	190	40	110	90	50	20	Jan. 1963
Network average	1.14	1.17	49	44	14.8	14.5	40	62	62	54	12	13	

* Las Vegas entered the network in July 1962.

are determined following radiochemical separation. The minimum detectable concentrations in units of μμc/liter are: Sr^{89}, 5; Sr^{90}, 1; I^{131}, 10; Cs^{137}, 5; and Ba^{140}, 10.

Table 1 presents summaries of all available analyses for September 1962. When a radionuclide is reported by a laboratory as being below the minimum detectable concentration, one-half of this value is used in calculating the monthly average. A similar procedure is used for the network average.

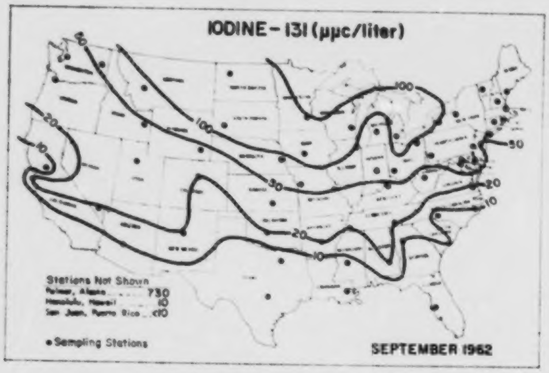
IODINE-131 (μμc/liter)
100
50
30
20
10
Stations Not Shown
Palmer, Alaska 730
Honolulu, Hawaii 10
San Juan, Puerto Rico .. <10
• Sampling Stations
SEPTEMBER 1962

FIGURE 1.—IODINE-131 CONCENTRATIONS IN PASTEURIZED MILK

Discussion of the Data

Iodine-131 September 1962 average concentration contours generally ran in an east-west direction (see figure 1). Only the southernmost part of the country had concentrations of iodine-131 below 10 μμc/liter. The northernmost part of the country had concentrations in excess of 100 μμc/liter. The station having the highest September average was Palmer, Alaska with 730 μμc/liter.

Strontium-89 September average concentration contours appeared somewhat like iodine-131 contours in that the intrusion of both radionuclides is from the north (see figure 2). Strontium-89 concentrations in milk were greater than 50 μμc/liter in the northern part of the country. The station with the highest September average was Palmer, Alaska with 175 μμc/liter.

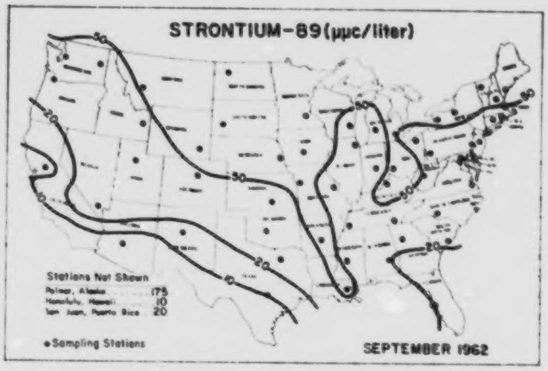
STRONTIUM-89 (μμc/liter)
50
30
20
10
Stations Not Shown
Palmer, Alaska 175
Honolulu, Hawaii 10
San Juan, Puerto Rico .. 20
• Sampling Stations
SEPTEMBER 1962

FIGURE 2.—STRONTIUM-89 CONCENTRATIONS IN PASTEURIZED MILK

Strontium-90 September average concentrations in milk were generally between 10 and 20 μμc/liter over the United States (see figure 3). The Southwest reported concentrations less than 10 μμc/liter. Strontium-90 concentrations greater than 20 μμc/liter occurred in the lower Mississippi Valley and in the North Carolina, Kentucky, West Virginia and Virginia area. The strontium-90 contour map for September appears similar to the one for August. The station reporting the highest September average strontium-90 concentration was New Orleans with 28 μμc/liter.

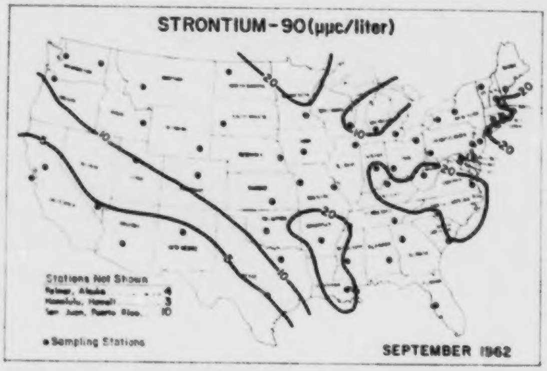
STRONTIUM-90 (μμc/liter)
20
10
Stations Not Shown
Palmer, Alaska 4
Honolulu, Hawaii 3
San Juan, Puerto Rico .. 10
• Sampling Stations
SEPTEMBER 1962

FIGURE 3.—STRONTIUM-90 CONCENTRATIONS IN PASTEURIZED MILK

Selected Monthly Strontium-90 Profiles

In previous issues of *RHD*, the average monthly strontium-90 concentrations in pasteurized milk from selected cities in the monitoring program were published. Profiles for an additional 16 cities are presented in figure 4. These graphs show the strontium-90 concentrations in milk from selected cities in the United States Department of Agriculture marketing regions of the United States.

25

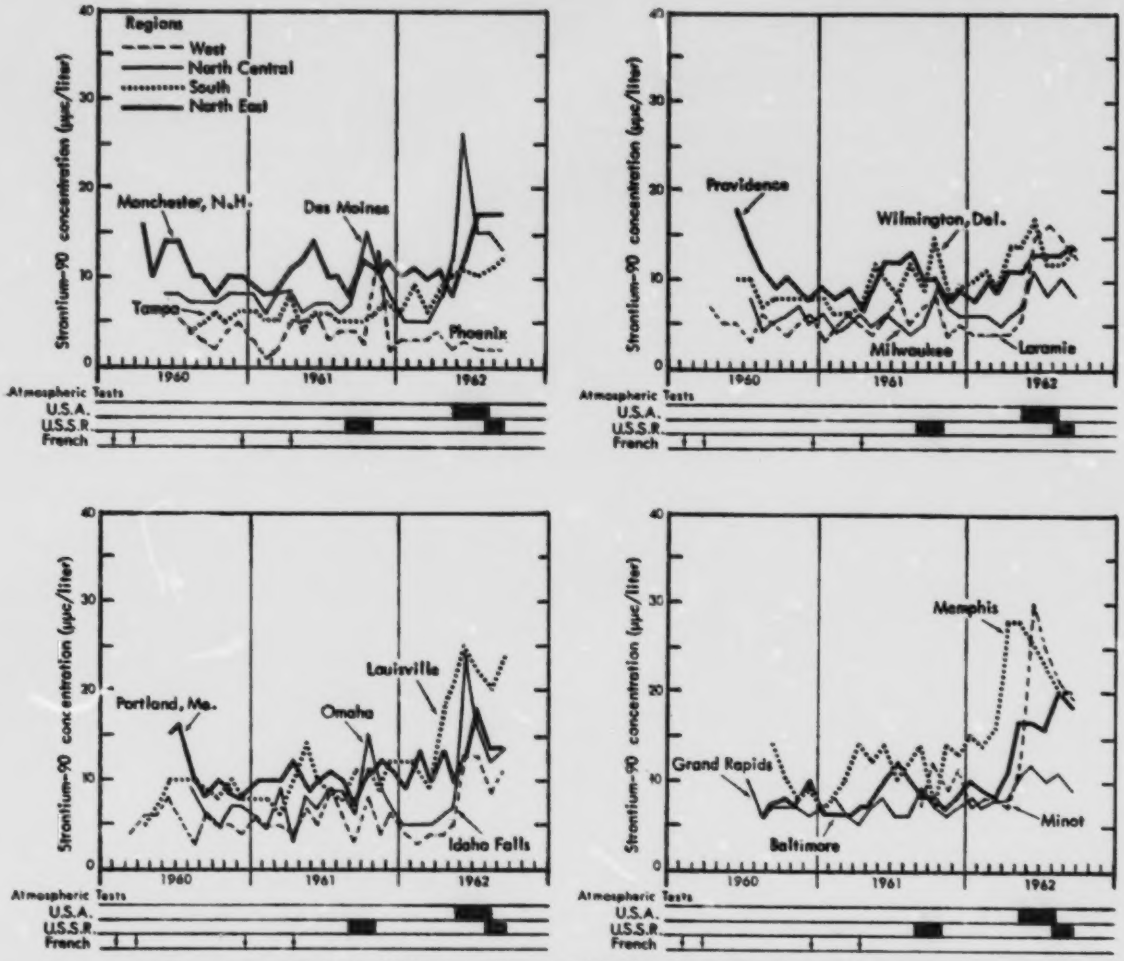

FIGURE 4.—STRONTIUM-90 CONCENTRATIONS IN PASTEURIZED MILK

INDIANA MILK NETWORK

September–October 1962

Bureau of Environmental Sanitation
Indiana State Board of Health

In September 1961, the Indiana State Board of Health initiated a program of milk sampling for radiological analyses. Indiana was geographically divided into five major milksheds and one large dairy within each milkshed was selected as a sampling station (see figure 5).

The milk samples are routinely analyzed for iodine-131, cesium-137, barium-lanthanum-140, strontium-89, and strontium-90. Analyses for iodine-131, cesium-137, and barium-lantha-

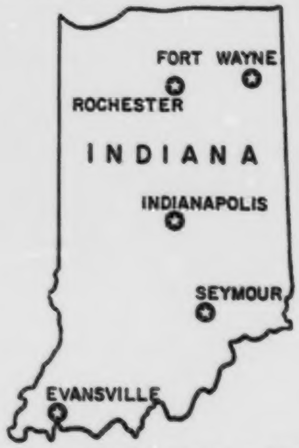

FIGURE 5.—INDIANA MILK SAMPLING LOCATIONS

TABLE 2.—INDIANA MILK NETWORK, SEPTEMBER-OCTOBER 1962

[Concentrations in μμc/liter]

Sampling locations	Strontium-89		Strontium-90		Iodine-131		Cesium-137		Barium-140	
	Sep. 1962	Oct. 1962	Sep. 1962	Oct. 1962	Sep. 1962	Oct. 1962	Sep. 1962	Oct. 1962	Sep. 1962	Oct. 1962
Evansville	160	95	25	14	70	80	20	35	<10	10
Fort Wayne	80	60	8	19	150	70	40	45	10	<10
Indianapolis	—	80	—	5	90	40	30	40	10	10
Rochester	140	85	12	13	130	70	40	50	10	<10
Seymour	140	100	5	4	60	40	35	40	10	<10
State average	130	85	12	11	100	60	35	40	10	<10

num–140 are conducted on a weekly basis except when iodine–131 results exceed 100 μμc/liter, at which time the frequency of sampling is increased. Samples which are analyzed for strontium–90 are composited weekly and analyzed monthly.

The trichloroacetic acid analytical procedure (*1*) is used for strontium–89 and strontium–90 analyses. A 512–channel pulse height analyzer and shielded 4″ x 4″ sodium iodide crystal are used for the gamma scintillation analysis of iodine–131, cesium–137, and barium-lanthanum–140.

The monthly averages of the data obtained for the individual sampling stations and the State averages are reported in table 2. The State average is an arithmetic average of the station values.

REFERENCE

(*1*) Robert A. Taft Sanitary Engineering Center, Public Health Service: *Radionuclide Analysis of Environmental Samples*, Technical Report, R59–6: 55–E–1 (November 16, 1959).

OREGON MILK NETWORK
July–October 1962

Division of Sanitation and Engineering
Oregon State Board of Health

With the cooperation of the Oregon State Department of Agriculture and the Oregon State University, the Oregon State Board of Health initiated a milk monitoring network in March 1962. Two 1–quart samples of packaged homogenized pasteurized milk are collected on a monthly basis by the Oregon Department of Agriculture and the City of Portland from seven milk districts throughout the State (see figure 6). Accelerated sampling on a weekly basis is performed when iodine–131 concentrations in milk exceed 100 pc/liter. The samples are forwarded to the Oregon State Board of Health radiation laboratory for iodine–131 and cesium–137 analyses. The analyses are performed utilizing a 3″ x 3″ sodium iodide scintillation crystal and a 512–channel pulse-height analyzer. All milk samples, after being gamma scanned, are frozen and stored for future strontium–90 analyses. Calibration is underway for barium–140 analysis.

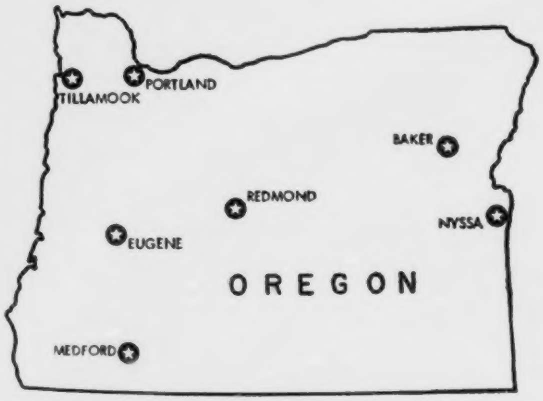

FIGURE 6.—OREGON PASTEURIZED MILK NETWORK SAMPLING STATIONS

Table 3 presents the Oregon milk monitoring data. During the period from March through June 1962, the milk samples analyzed

Table 3.—RADIONUCLIDE CONCENTRATIONS IN OREGON MILK, JULY–OCTOBER 1962

[Average concentrations in pc/liter]

Station and radionuclide	July	August	September	October
Portland (composite)				
Iodine-131	<15	20	40	80
Cesium-137	70	70	55	105
Portland (local producer)				
Iodine-131	<15	15	35	50
Cesium-137	55	60	55	70
Tillamook				
Iodine-131	[a] <15	[a] <15	[a] 30	140
Cesium-137	[a] 100	[a] 145	[a] 80	220
Medford				
Iodine-131	[a] <15	[a] <15	[a] 30	[a] 100
Cesium-137	[a] 35	[a] 15	[a] 20	[a] 50
Redmond				
Iodine-131	[a] <15	[a] <15	105	65
Cesium-137	[a] 40	[a] 40	45	40
Eugene				
Iodine-131	[a] <15	[a] 15	[a] 20	[a] 30
Cesium-137	[a] 30	[a] 30	[a] 50	[a] 80
Baker				
Iodine-131	[a] 40	[a] <15	100	75
Cesium-137	[a] 60	[a] 85	50	50
Nyssa				
Iodine-131	—	[a] <15	50	[a] 50
Cesium-137	—	[a] 60	55	[a] 50

[a] Based on one sample, all others more than one.

by the State Board of Health for iodine–131 had concentrations less than the minimum detectable concentration of 15 pc/liter.

As a continuing check on the validity of the data, a split sample of the official U.S. Public Health Service pasteurized milk sample from Portland is obtained on a weekly basis for analysis. These data are compared to the Public Health Service data in figure 7.

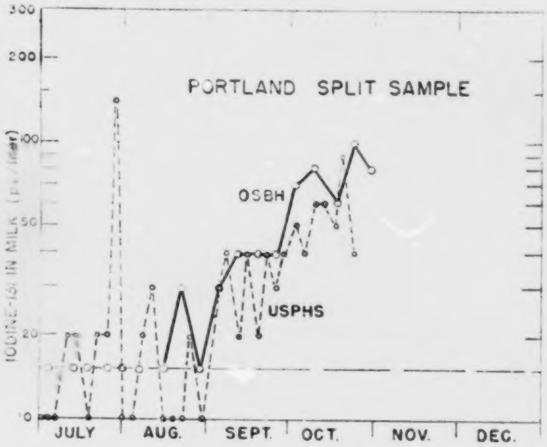

Figure 7.—COMPARISON OF PUBLIC HEALTH SERVICE AND OREGON STATE BOARD OF HEALTH MILK ANALYSES FOR PORTLAND, 1962

RADIOSTRONTIUM IN MILK (*1*)
March–June 1962

Health and Safety Laboratory
U.S. Atomic Energy Commission

The Health and Safety Laboratory (HASL) began monitoring liquid whole milk in New York City in 1954 for strontium–90 in order to estimate the dietary contribution from the ingestion of radiostrontium in milk. Subsequently, powdered milk monitoring was initiated at Perry, New York, and at Mandan, North Dakota. Liquid whole milk monitoring was started in Honolulu, Hawaii in August 1959.

The New York City sample is a monthly composite of pasteurized milk purchased daily in quart containers at retail stores. Five large dairies are represented in the sample. The Honolulu sample is a monthly composite of pasteurized milk collected weekly. Samples from two dairies are analyzed and the results are averaged. The Mandan and Perry samples are monthly composites of powdered milk collected in 5–pound lots from plants in each city. The Mandan sample is powdered buttermilk used for cattle feed, while the Perry sample is powdered whole milk used for human con-

TABLE 4.—RADIOSTRONTIUM AND CALCIUM IN LIQUID MILK, MARCH–JUNE 1962

Sampling station and period	Calcium (g/liter)	Strontium-90 (μμc/liter)	Strontium-90 (μμc/g Ca)	Sr^{89}/Sr^{90}[a]
New York City				
1959 Average			11	
1960 Average			8.0	
1961 Average			6.7	
1962 March	1.23	4.9	4.0	1
April	1.02	9.3	9.1	10
May	1.26	18.7	14.8	6
June	1.00	8.9	8.9	8
Honolulu, Hawaii				
1959 Average			5.0	
1960 Average			3.2	
1961 Average			2.4	
1962 March	1.06	3.3	3.1	10
April	1.05	5.2	4.8	8
May	1.14	4.8	4.2	6
June	1.10	3.5	3.2	6

[a] Strontium-89 value extrapolated to the midpoint of sampling period.

sumption. The Honolulu data are of interest since the cows there are on pasture throughout the year and soil analyses have shown strontium–90 concentrations in soils in Hawaii to be comparable with those in the New York area (*2*).

Strontium–89 became measurable in September 1961, indicating that fresh fission products from the U.S.S.R. nuclear test series were being deposited. The Sr^{89}/Sr^{90} ratios are presented in tables 4 and 5, as are the calcium and strontium data for March 1962 through June 1962. The fluctuations of strontium–90 with time are shown in figures 8 and 9.

TABLE 5.—RADIOSTRONTIUM AND CALCIUM IN POWDERED MILK AND BUTTERMILK, MARCH–JUNE 1962

Sampling station and period	Calcium (g/kg)	Strontium-90 (μμc/kg)	Strontium-90 (μμc/g Ca)	Sr^{89}/Sr^{90}[a]
Powdered milk				
Perry, New York				
1959 Average			8.0	
1960 Average			6.5	
1961 Average			6.2	
1962 March	8.9	50	5.6	1
April	9.1	51	5.6	1
May	9.6	84	8.8	3
June	9.0	116	13.0	4
Powdered buttermilk				
Mandan, North Dakota				
1959 Average			25.7	
1960 Average			15.0	
1961 Average			9.4	
1962 March	11.4	181	16.0	1
April	13.1	270	20.6	2
May	11.6	333	28.7	8
June	11.0	316	28.8	7

[a] Strontium-89 value extrapolated to the midpoint of sampling period.

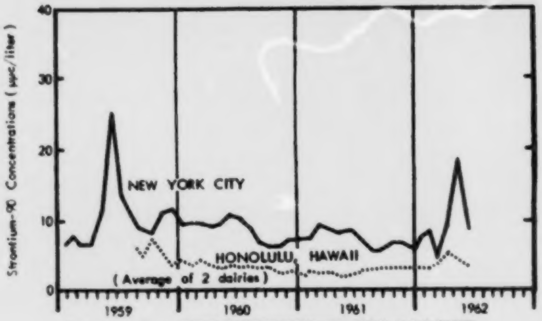

FIGURE 8.—STRONTIUM–90 IN LIQUID MILK SAMPLES

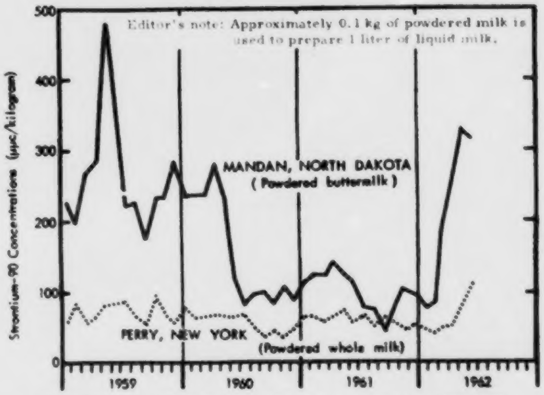
Editor's note: Approximately 0.1 kg of powdered milk is used to prepare 1 liter of liquid milk.

FIGURE 9.—STRONTIUM–90 IN POWDERED MILK SAMPLES

REFERENCES

(*1*) U.S. Atomic Energy Commission: *Fallout Program Quarterly Summary Report, HASL–131*, Office of Technical Services, Department of Commerce, Washington 25, D.C. (October 1, 1962), price $3.50.

(*2*) U.S. Atomic Energy Commission: *Summary of Available Data on the Strontium–90 Content of Foods and of Total Diets in the United States, HASL–90*:4, Office of Technical Services, Department of Commerce, Washington 25, D.C. (August 18, 1960).

Previous coverage in *Radiological Health Data:*

Period	Issue
December 1960–April 1961	*December 1961*
May–July 1961	*March 1962*
August–December 1961	*June 1962*
January–February 1962	*September 1962*

RADIONUCLIDES IN CANADIAN DRIED MILK PRODUCTS

Second Quarter 1962

Radioactive Fallout Study Program
Department of National Health and Welfare,
Ottawa, Canada

Beginning in November 1955, radiochemical analyses of skim milk and buttermilk powders for strontium-90 concentrations were initiated by the Department of National Health and Welfare. Since April 1962, analyses for strontium-89 and cesium-137 have also been included.

Samples are collected through the cooperation of the Marketing Division of the Canadian Department of Agriculture, whose dairy products inspectors pick up four 1-pound samples of dried milk from each station on a monthly schedule.

No statistical plan is followed for sample collection. Because of uncertainties introduced by this method of sampling, the significance of differences between station-to-station and month-to-month results is not precisely known. However, it is possible to consider all results for a given period of time as being sufficiently random in selection to show any national trend when average values for such periods and all stations are plotted, as in figure 11. It should be emphasized that average concentrations over a considerable period of time are more meaningful from the public health point of view than fluctuating monthly concentrations.

A detailed discussion of the sampling and radiochemical procedures employed may be found in the Department's publication (*1*). Table 6 presents the results of measurements of strontium-89, strontium-90 and cesium-137 in Canadian dried milk powder for the second quarter of 1962. These data were taken from the "Quarterly Report of the Radioactive Fall-

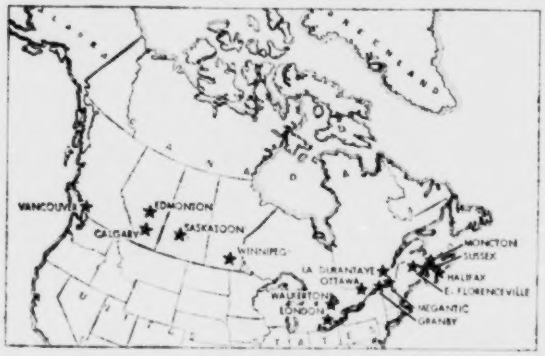

FIGURE 10.—CANADIAN DRIED MILK SAMPLING STATIONS

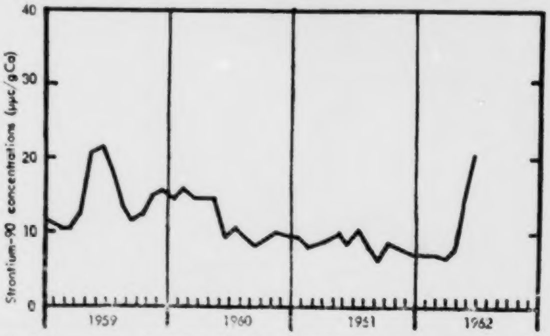

FIGURE 11.—AVERAGE STRONTIUM-90 CONCENTRATIONS IN CANADIAN DRIED MILK PRODUCTS

TABLE 6.—RADIONUCLIDES IN CANADIAN DRIED MILK POWDER, 1962

Station	Strontium-89 (µµc/g Ca)			Strontium-90 (µµc/g Ca)			Cesium-137 (µµc/g K)		
	April	May	June	April	May	June	April	May	June
Arborg [a]	2.6	40.0	90.6	4.3	7.7	18.0	12.2	34.7	36.1
Calgary [a]	60.0	203	240	12.1	25.6	20.3	42.3	54.2	83.5
E. Florenceville [a]	32.5	38.8	81.5	10.1	13.6	18.7	—	29.5	63.5
Edmonton	29.6	254	210	6.5	29.0	28.8	27.1	63.3	84.7
Grunthal	2.7	148	129	3.9	14.8	18.6	4.2	47.7	60.7
Halifax	0	29.6	46.0	6.7	9.9	21.9	10.4	28.8	80.5
La Durantaye	—	2.2	127	—	10.8	26.3	—	25.0	101
Lawrenceville	0	3.6	118	11.8	12.9	23.8	36.2	—	153.4
London	1.7	25.7	75.1	3.3	5.7	9.7	5.1	16.4	60.0
Megantic	0.5	36.3	136	16.0	18.6	38.2	28.6	52.0	114.7
Moncton	1.3	16.6	126	7.4	10.0	27.8	19.4	25.0	72.2
Nicolet	1.1	6.8	48.1	6.1	7.9	8.6	17.6	34.9	42.1
Ottawa	10.4	22.2	49.4	8.2	7.2	10.7	—	17.6	42.9
Saskatoon [a]	15.0	154	125	6.0	18.4	19.5	5.7	32.3	47.6
Sussex	1.2	3.7	84.5	8.9	7.8	19.8	14.4	—	58.1
Vancouver	62.4	223	101	12.3	23.0	24.5	51.3	—	144.6
Walkerton	5.4	86.2	124	6.3	9.8	8.8	10.2	37.6	77.7
Average	14.2	76.1	112	8.1	13.7	20.2	20.3	35.6	77.8

[a] Buttermilk—All other samples were skim milk powders

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out Monitoring Program," dated August 1962, published by the Radiation Protection Division of the Department of National Health and Welfare.

The strontium-90 concentrations in milk increased during the second quarter of 1962. The maximum average of all stations during the quarter was 20.2 μμc/g Ca in June. The Canadian average for the preceding twelve-month period was 9.3 μμc/g Ca, and the previous record high of 21.3 μμc/g Ca occurred in June 1959.

For an approximate method to compare the Canadian powdered milk data in units of μμc/g Ca to other milk data in units of μμc/liter, it can be assumed that milk has approximately 1.2 g Ca/liter of liquid milk. Canadian powdered milk data may be compared to liquid milk data by multiplying the former values by 0.8.

REFERENCE

(1) Radiation Protection Division, Department of National Health and Welfare, Ottawa, Canada: *Preliminary Report on the Measurements of Radioactive Strontium in Canadian Milk Powder Samples, CNHW (RP-1)*, (July 1958).

Twelve-Month Sum of Daily Radionuclide Content of One Liter of Pasteurized Milk

November 1961–October 1962: Iodine–131
October 1961–September 1962: Strontium–89 and Strontium–90

Division of Radiological Health, Public Health Service

The guidance of the Federal Radiation Council is given in terms of transient rates of intake of radioactive materials in micromicrocuries per day. The ranges are based on radiation doses considered acceptable for lifetime exposure from normal peacetime atomic industry operations. The Council recommends the use of a time period of one year as an appropriate interval for averaging exposures. The Council has recently emphasized that the annual acceptable exposure dose is not a "danger point" which, if exceeded, requires protective measures (*1*, *2*, *3*).

To facilitate comparison of the concentrations of certain radionuclides in milk with the Radiation Protection Guides, tables 1 and 2 below furnish a means towards estimating the contribution of milk to the total dietary intake of iodine–131, strontium–89, and strontium–90. The tables are based on the same data which are used for computing the Pasteurized Milk Network monthly averages. They present index values which are the estimated sums of the daily amounts of a radionuclide in one liter of milk for a 12–month period.

The tables show 12–month index values for each of the Network's 62 sampling locations. Due to the longer time required for strontium–89 and strontium–90 analysis, these 12–month index values are for the year beginning one month earlier than the iodine–131 values. The columns of monthly index values in each table are used to compute the net change as the yearly index values are advanced by one month. The following column shows this new 12–month index value. In addition, the first column in table 1 gives the iodine–131 October concentration averages.

The data in tables 1 and 2 are calculated as follows: (a) results from all samples collected in each week (Sunday through Saturday) are averaged, (b) the weekly averages for all weeks ending within a given month are averaged and an average for the month is obtained, and (c) the monthly radionuclide index value is determined by multiplying the average for the month by the number of days in the month. The number of days in the month will be either 28 or 35, corresponding to the complete calendar weeks used for any month. Procedures exemplified by (a) and (b) above minimize the effect of any one day's sample results on the average for the month, particularly for a short-lived radionuclide such as iodine–131.

For a number of reasons it is desirable to have a standard quantity of milk to use in the development of index values for the different radionuclides. In the case of strontium, 1 liter is a suitable quantity as this amount of milk supplies approximately 1 gram of calcium, the amount used by the Federal Radiation Council in deriving the intake guidance for strontium. In the case of iodine-131, the critical age group is the young infant. Available information suggests that the average milk consumption of infants in the 6–18 month group is not more than 1 liter per day. Thus the index value based on 1 liter of milk, though not directly an average intake value, is probably the most useful index for estimating total intake.

TABLE 1.—TWELVE-MONTH SUM OF DAILY AMOUNTS OF IODINE-131 IN ONE LITER OF MILK

Sampling locations		Oct. 1962 iodine-131 averages (μμc/liter)	Iodine-131 index values (μμc day/liter)[a]			
			Oct 1961–Sep 1962	Oct 1961	Sep 30, 1962–Oct 27, 1962	Nov 1961–Oct 1962
Ala:	Montgomery	10	4,450	930	280	3,800
Alaska:	Palmer	270	39,660	10,230	7,560	36,990
Ariz:	Phoenix	10	7,010	1,860	280	5,430
Ark:	Little Rock	50	11,960	3,720	1,400	9,640
Calif:	Sacramento	10	4,640	620	280	4,300
	San Francisco	10	4,690	620	280	4,350
Colo:	Denver	20	8,570	2,790	560	6,340
Conn:	Hartford	70	6,880	1,860	1,960	6,980
Del:	Wilmington	70	8,270	1,860	1,960	8,370
D.C.:	Washington	60	6,540	1,860	1,680	6,360
Fla:	Tampa	10	4,610	1,240	280	3,650
Ga:	Atlanta	20	7,140	2,480	560	5,220
Hawaii:	Honolulu	<10	4,190	620	140	3,710
Idaho:	Idaho Falls	40	13,670	4,340	1,120	10,450
Ill:	Chicago	120	14,860	4,650	3,360	13,570
Ind:	Indianapolis	90	9,360	2,170	2,520	9,710
Iowa:	Des Moines	120	28,250	8,990	3,360	22,620
Kans:	Wichita	60	23,890	4,030	1,680	21,540
Ky:	Louisville	40	9,490	2,790	1,120	7,820
La:	New Orleans	30	7,320	2,480	840	5,680
Maine:	Portland	60	8,810	3,720	1,680	6,770
Md:	Baltimore	60	7,100	2,170	1,680	6,610
Mass:	Boston	90	9,500	4,030	2,520	7,990
Mich:	Detroit	120	15,750	6,510	3,360	12,600
	Grand Rapids	90	9,410	2,790	2,520	9,140
Minn:	Minneapolis	100	25,360	10,540	2,800	17,620
Miss:	Jackson	20	8,250	2,790	560	6,020
Mo:	Kansas City	80	31,250	4,650	2,240	28,840
	St. Louis	60	15,410	4,960	1,680	12,130
Mont:	Helena	70	16,300	4,960	1,960	13,300
Nebr:	Omaha	80	23,020	7,750	2,240	17,510
Nev:	Las Vegas[b]	20	2,940	[c] —	560	3,500
N.H.:	Manchester	70	8,320	3,100	1,960	7,180
N.J.:	Trenton	60	6,940	2,790	1,680	5,830
N. Mex:	Albuquerque	20	7,220	930	560	6,850
N.Y.:	Buffalo	90	9,150	3,100	2,520	8,570
	New York	130	9,540	3,100	3,640	10,080
	Syracuse	100	11,110	4,340	2,800	9,570
N.C.:	Charlotte	10	3,550	1,240	280	2,590
N.D.:	Minot	100	15,040	4,340	2,800	13,500
Ohio:	Cincinnati	80	12,180	3,100	2,240	11,320
	Cleveland	100	9,420	3,100	2,800	9,120
Okla:	Oklahoma City	30	17,130	2,790	840	15,180
Ore:	Portland	60	11,230	1,860	1,680	11,050
Pa:	Philadelphia	70	7,870	2,480	1,960	7,3[illegible]
	Pittsburgh	110	8,930	2,790	3,080	9,220
P.R.:	San Juan	<10	4,470	620	140	3,990
R.I.:	Providence	70	7,680	2,480	1,960	7,160
S.C.:	Charleston	20	4,810	1,860	560	3,510
S.D.:	Rapid City[d]	80	7,950	—	2,240	10,190
Tenn:	Chattanooga	20	6,930	2,480	560	5,010
	Memphis	40	10,810	4,960	1,120	6,970
Tex.:	Austin	10	4,730	930	280	4,080
	Dallas	30	7,640	1,240	840	7,240
Utah:	Salt Lake City	60	34,240	3,720	1,680	32,200
Vt.:	Burlington	100	8,200	3,100	2,800	7,900
Va.:	Norfolk	40	5,900	2,480	1,120	4,540
Wash:	Seattle	60	12,030	3,720	1,680	9,990
	Spokane	40	24,090	3,720	1,120	21,490
W. Va.:	Charleston	30	5,950	1,860	840	4,930
Wis.:	Milwaukee	140	14,110	4,650	3,920	13,380
Wyo.:	Laramie	30	20,990	1,240	840	20,500

[a] The data in this table are index values, not to be interpreted as consumption or total intake values. Annual I^{131} intake per person may be calculated from an index value in this table by applying the appropriate factor representing average individual daily milk consumption for any selected group under consideration.

Example: 12-month I^{131} index (μμc day/liter) × milk consumption factor (liter/day/person) = 12-month I^{131} intake (μμc/person)

[b] Station began operation in July 1962.
[c] Dash indicates no data available.
[d] Station began operation in January 1962.

REFERENCES

(*1*) **Chadwick, Donald R. and Conrad P. Straub: Considerations in Establ[illegible] Radiation Protection Standards for Radioactiv[illegible] in the Environment, *Radiological Health Data, 3*:15[illegible]–65 (May 1962).**

(*2*) **Federal Radiation Counc[illegible]: *Background Material for the Development of Radiation Protection Standards, Report No. 2*, Superintendent of Documents, U.S. Government Printing Office (September 1961), price 20 cents.**

(*3*) **Public Health Service: *Radiological Health Data, 3*:ii–iii (September 1962).**

TABLE 2.—TWELVE-MONTH SUM OF DAILY AMOUNTS OF STRONTIUM-89 AND STRONTIUM-90 IN ONE LITER OF MILK

Sampling locations		Strontium-89 index values (μμc day/liter)[a]				Strontium-90 index values (μμc day/liter)[a]			
		Sep 1961–Aug 1962	Sep 1961	Aug 26, 1962–Sep 29, 1962	Oct 1961–Sep 1962	Sep 1961–Aug 1962	Sep 1961	Aug 26, 1962–Sep 29, 1962	Oct 1961–Sep 1962
Ala:	Montgomery [b]	[c] 18,065	[d] —	700	18,765	4,087	—	420	4,507
Alaska:	Palmer	[c] 10,775	—	6,125	16,900	3,233	210	490	3,513
Ariz:	Phoenix	[c] 5,100	—	90	5,190	1,292	120	70	1,242
Ark:	Little Rock	[c] 41,220	—	1,925	43,145	8,890	480	945	9,355
Calif:	Sacramento	6,675	750	90	6,015	1,570	180	70	1,460
	San Francisco	[c] 10,170	—	350	10,520	1,844	120	105	1,829
Colo:	Denver	9,215	150	1,575	10,640	2,839	150	420	3,109
Conn:	Hartford	[c] 5,715	—	1,225	6,940	3,410	210	455	3,655
Del.	Wilmington	[c] 11,215	—	1,925	13,140	4,189	270	490	4,409
D.C:	Washington	11,330	300	1,050	12,080	3,937	210	630	4,357
Fla.	Tampa	7,235	80	700	7,855	2,831	150	420	3,101
Ga:	Atlanta	26,740	150	1,225	27,815	5,601	270	595	5,926
Hawaii:	Honolulu	[c] 8,770	—	350	9,120	1,914	210	105	1,809
Idaho:	Idaho Falls	[c] 7,905	—	1,050	8,955	2,299	90	385	2,594
Ill:	Chicago	10,740	600	1,400	11,540	3,116	150	525	3,491
Ind:	Indianapolis	[c] 11,060	—	1,575	12,635	3,880	180	735	4,435
Iowa:	Des Moines	[c] 20,535	—	2,275	22,810	4,013	210	455	4,258
Kans:	Wichita	[c] 15,335	—	1,575	16,910	3,760	390	420	3,790
Ky:	Louisville	[c] 21,150	—	1,925	23,075	5,400	330	840	5,910
La:	New Orleans	63,905	300	1,925	65,530	9,464	390	980	10,054
Maine:	Portland	10,455	600	2,100	11,955	4,204	210	490	4,484
Md:	Baltimore	[c] 9,940	—	1,225	11,165	4,145	240	630	4,535
Mass:	Boston	[c] 11,035	—	1,750	12,785	4,424	270	875	5,029
Mich:	Detroit	[c] 7,835	—	1,750	9,585	2,999	180	385	3,204
	Grand Rapids	[c] 9,360	—	1,575	10,935	3,116	270	315	3,161
Minn:	Minneapolis	[c] 21,055	—	2,975	24,030	4,347	150	665	4,862
Miss:	Jackson	54,635	300	1,575	55,910	8,083	390	630	8,323
Mo:	Kansas City	[c] 26,465	—	1,925	28,390	4,258	210	455	4,503
	St. Louis	16,855	900	1,400	17,355	4,307	300	420	4,427
Mont:	Helena	[c] 11,585	—	1,925	13,510	3,133	300	595	3,428
Nebr:	Omaha	[c] 22,155	—	2,100	24,255	3,846	180	490	4,156
Nev:	Las Vegas [e]	[c] 1,120	—	1,225	2,345	252	—	175	427
N.H:	Manchester	[c] 7,110	—	2,275	9,385	4,146	240	595	4,501
N.J:	Trenton	[c] 7,310	—	1,575	8,885	3,268	240	630	3,658
N. Mex:	Albuquerque	[c] 4,150	—	525	4,675	1,595	90	140	1,645
N.Y:	Buffalo	[c] 6,870	—	1,925	8,795	3,460	210	490	3,740
	New York	8,165	300	1,575	9,440	3,841	300	700	4,241
	Syracuse	[c] 8,270	—	2,100	10,370	3,021	180	525	3,366
N.C:	Charlotte	[c] 17,045	—	1,400	18,445	5,752	330	700	6,122
N.D:	Minot	14,330	450	2,800	16,680	4,756	210	665	5,211
Ohio:	Cincinnati	[c] 14,765	—	1,925	16,690	4,367	300	420	4,487
	Cleveland	[c] 8,400	—	1,225	9,625	3,326	240	560	3,646
Okla:	Oklahoma City	[c] 23,625	—	1,225	24,850	4,663	180	630	5,113
Ore:	Portland	[c] 21,075	—	875	21,950	4,582	240	385	4,727
Pa:	Philadelphia	[c] 7,885	—	1,225	9,110	3,589	180	595	4,004
	Pittsburgh	[c] 9,270	—	1,575	10,845	4,376	300	665	4,741
P.R:	San Juan	[c] 23,200	—	700	23,900	3,000	150	350	3,200
R.I:	Providence	[c] 9,860	—	1,400	11,260	3,739	300	490	3,929
S.C:	Charleston	20,475	150	875	21,200	5,694	360	700	6,034
S.D:	Rapid City [f]	[c] 13,555	—	1,925	15,480	3,592	—	490	4,082
Tenn:	Chattanooga	[c] 36,855	—	1,400	38,255	6,802	360	665	7,107
	Memphis	[c] 34,530	—	1,400	35,930	6,468	420	700	6,748
Tex:	Austin	9,285	80	350	9,555	2,133	90	175	2,218
	Dallas	22,195	150	875	22,920	4,326	150	420	4,596
Utah:	Salt Lake City	9,155	300	1,225	10,080	2,492	150	350	2,692
Vt:	Burlington	[c] 7,300	—	2,275	9,575	3,287	180	595	3,702
Va:	Norfolk	[c] 17,335	—	1,225	18,560	5,037	300	735	5,472
Wash:	Seattle	17,410	750	1,575	18,235	4,492	330	630	4,792
	Spokane	[c] 9,505	—	1,050	10,555	3,389	180	420	3,629
W. Va:	Charleston	[c] 18,780	—	1,750	20,530	5,180	360	735	5,555
Wis:	Milwaukee	[c] 6,270	—	1,400	7,670	2,583	150	280	2,713
Wyo:	Laramie	[c] 11,525	—	3,325	14,850	2,766	210	455	3,011

[a] The data in this table are index values, not to be interpreted as consumption or total intake values. Annual strontium-89 or strontium-90 intake per person may be calculated from an index value in this table by applying the appropriate factor representing average daily milk consumption for any selected group under consideration.

Example: 12-month index value (μμc day/liter) × milk consumption factor (liter/day/person) = 12-month intake (μμc/person)

[b] Station began operation in October 1961. [c] Index value is for 11 months; no data available for September 1961. [d] Dash indicates no data are available. [e] Station began operation in July 1962. [f] Station began operation in January 1962.

SECTION IV.—WATER

Radioactivity in Raw Surface Waters

NATIONAL WATER QUALITY NETWORK
July 1962

Division of Water Supply and Pollution Control, Public Health Service

The National Water Quality Network was initiated in October 1957 (*1*). This network, operated by the Public Health Service in cooperation with State and local agencies, consisted of 120 stations as of the end of July (figure 1). These stations are located on the major waterways used for public water supplies, propagation of fish and wildlife, and recreational, agricultural, and industrial purposes. Samples are taken weekly, monthly, or continuously, depending on the type of analysis and the water quality. These samples are analyzed for plankton population, organic chemicals, chemical, biological, and physical quality, and radioactivity (*2, 3*).

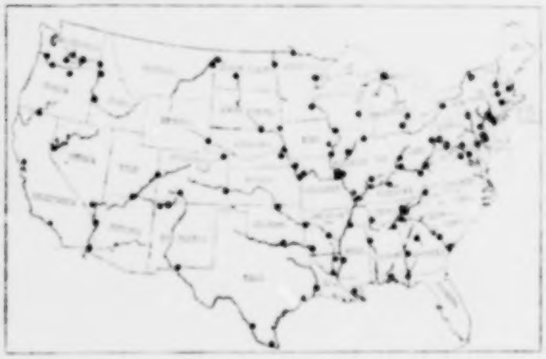

FIGURE 1.—NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS, JULY 1962

The radioactivity associated with dissolved solids provides a rough measure of the levels which may be found in treated water, since nearly all of the suspended matter is removed by treatment processes (*4*). It has been observed that in water the natural environmental beta activity is usually several times that of the natural environmental alpha activity. Nuclear installations may contribute additional alpha or beta activity whereas fallout contributes primarily additional beta activity. Gross alpha and beta measurements are made on both suspended and dissolved solids (strontium–90 on the total solids only) in raw surface water samples according to established procedures (*5, 6*). Because strontium–90 analyses are done quarterly, the results will be published on this basis.

For the first two years, beta determinations were made on weekly samples and alpha determinations were generally made on composites of more than one weekly sample. From January 1960 to September 1961, alpha and beta determinations were generally made once a month

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS

[Average concentrations in μc/liter]

Station	July 1962					
	Beta activity			Alpha activity		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Allegheny River: Pittsburgh, Pa	0	12	12	—	—	—
Animas River: Cedar Hill, N. Mex	2	13	15	0	2	2
Apalachicola River: Chattahoochie, Fla	3	12	15	—	—	—
Arkansas River:						
Coolidge, Kansas	22	97	119	3	40	43
Ponca City, Okla	45	68	113	—	—	—
Pendleton Ferry, Ark	—	—	—	—	—	—
Bighorn River: Hardin, Mont	108	45	153	11	3	14
Big Sioux River: Sioux Falls, So. Dak	23	55	78	—	—	—
Chattahoochie River:						
Atlanta, Ga	7	10	17	0	0	0
Columbus, Ga	1	5	6	0	0	0
Lanett, Ala	2	4	6	0	0	0
Chena Slough: Fairbanks, Alaska	3	8	11	1	0	1
Clear Water River: East Lewiston, Idaho	—	—	—	—	—	—
Clinch River:						
Kingston, Tenn	65	205	270	0	0	0
Clinton, Tenn	2	7	9	0	0	0
Colorado River:						
Loma, Colo	15	33	48	2	1	3
Page, Ariz	—	—	—	—	—	—
Boulder City, Nev	0	38	38	0	3	3
Parker Dam, Calif. Ariz	6	12	18	0	8	8
Yuma, Ariz	37	17	54	5	2	7
Columbia River:						
Northport, Wash	4	12	16	0	<1	<1
Wenatchee, Wash	—	—	—	—	—	—
Pasco, Wash	9	116	125	0	0	0
McNary Dam, Ore	16	86	102	0	0	0
Bonneville, Ore	—	—	—	—	—	—
Clatskanie, Ore	—	—	—	—	—	—
Connecticut River:						
Wilder, Vt	2	15	17	0	0	0
Northfield, Mass	5	13	18	0	0	0
Enfield Dam, Conn	4	11	15	<1	0	<1
Cumberland River: Clarksville, Tenn	—	—	—	—	—	—
Delaware River:						
Martins Creek, Pa	3	12	15	0	0	0
Trenton, N. J	3	10	13	0	0	0
Philadelphia, Pa	4	22	26	—	—	—
Escambia River: Century, Fla	10	19	29	0	0	0
Great Lakes:						
Duluth, Minn	0	4	4	0	<1	<1
Sault Ste. Marie, Mich	3	8	11	—	—	—
Milwaukee, Wis	3	10	13	0	0	0
Gary, Ind	12	20	32	0	0	0
Port Huron, Mich	2	8	10	—	—	—
Detroit, Mich	1	8	9	0	0	0
Buffalo, N. Y	4	15	19	0	0	0
Hudson River: Poughkeepsie, N. Y	6	7	13	—	—	—
Illinois River:						
Peoria, Ill	6	37	43	1	0	1
Grafton, Ill	7	33	40	<1	2	3
Kanawha River: Winfield Dam, W. Va	—	—	—	—	—	—
Klamath River: Keno, Ore	4	12	16	0	0	0
Little Miami River: Cincinnati, Ohio	20	36	56	—	—	—
Mississippi River:						
St. Paul, Minn	20	52	72	—	—	—
Dubuque, Iowa	76	40	116	9	3	12
Burlington, Iowa	29	35	64	0	0	0
E. St. Louis, Ill	13	33	46	—	—	—
Cape Girardeau, Mo	41	35	76	47	1	48
W. Memphis, Ark	30	25	55	6	0	6
Delta, La	30	30	60	3	2	5
New Orleans, La	173	2	175	—	—	—
Vicksburg, Miss	20	20	40	2	<1	3
Missouri River:						
Williston, N. Dak	170	19	189	—	—	—
Bismarck, N. Dak	8	31	39	<1	1	2
Yankton, S. Dak	5	27	32	—	—	—
Omaha, Nebr	73	45	118	—	—	—
St. Joseph, Mo	114	46	160	1	0	1
Kansas City, Kans	16	21	37	1	0	1
St. Louis, Mo	138	6	144	—	—	—
Missouri City, Mo	35	20	55	15	4	19
Monongahela River: Pittsburgh, Pa	2	22	24	0	0	0
North Platte River: Henry, Nebr	84	80	164	4	14	18
Ohio River:						
Addison, Ohio	6	16	22	0	<1	<1
East Liverpool, Ohio	4	10	14	—	—	—
Huntington, W. Va	1	14	15	0	0	0
Cincinnati, Ohio	8	14	22	0	0	0
Louisville, Ky	—	—	—	—	—	—
Evansville, Ind	—	—	—	—	—	—
Cairo, Ill	2	24	26	0	1	1
Ouachita River: Bastrop, La	12	36	48	<1	0	<1
Pend Oreille River: Albeni Fall Dam, Idaho	7	11	18	0	0	0
Platte River: Plattsmouth, Nebr	63	59	122	5	5	10

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS—Continued

[Average concentrations in pc/liter]

Station	July 1962					
	Beta activity			Alpha activity		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Potomac River:						
Williamsport, Md	—	—	—	—	—	—
Great Falls, Md	2	7	9	—	—	—
Rainy River:						
Baudette, Minn	10	43	53	0	<1	<1
International Fls, Minn	—	—	—	—	—	—
Red River, North: Grand Forks, N. D	—	—	—	—	—	—
Red River, South:						
Denison, Tex	9	37	46	—	—	—
Index, Ark	—	—	—	—	—	—
Bossier City, La	25	41	66	1	1	2
Alexandria, La	9	26	35	5	2	7
Rio Grande River:						
Alamosa, Colo	62	26	88	0	0	0
El Paso, Tex	16	25	41	—	—	—
Laredo, Tex	381	34	415	0	1	1
Brownsville, Tex	16	46	62	0	2	2
Roanoke River: John H. Kerr Resr. & Dam, Va	13	13	26	1	0	1
Sabine River: Ruliff, Tex	10	14	24	0	0	0
Sacramento River: Greens Landing, Courtland, Calif	2	9	11	0	0	0
San Joaquin River: Vernalis, Calif	8	21	29	0	4	4
San Juan River: Shiprock, N. Mex	17	18	35	4	10	14
St. Lawrence River: Massena, N. Y	2	10	12	—	—	—
Schuylkill River: Philadelphia, Pa	6	13	19	0	0	0
Savannah River:						
North Augusta, S. C	9	7	16	0	0	0
Port Wentworth, Ga	7	28	35	0	0	0
Shenandoah River: Berryville, Va	—	—	—	—	—	—
Ship Creek: Anchorage, Alaska	3	10	13	1	0	1
Snake River:						
Payette, Idaho	4	27	31	—	—	—
Wawawai, Wash	4	10	14	0	0	0
South Platte River: Julesburg, Colo	71	58	129	19	28	47
Spokane River: Post Falls, Idaho	4	10	14	0	0	0
Susquehanna River:						
Sayre, Pa	4	11	15	—	—	—
Conowingo, Md	—	—	—	—	—	—
Tennessee River:						
Chattanooga, Tenn	—	—	—	—	—	—
Bridgeport, Ala	8	39	47	0	0	0
Pickwick Landing, Tenn	7	21	28	<1	0	<1
Tombigbee River: Columbus, Miss	28	18	46	2	<1	3
Truckee River: Farad, Calif	4	10	14	0	<1	<1
Verdigris River: Nowata, Okla	12	34	46	<1	0	<1
Wabash River: New Harmony, Ind	9	26	35	1	2	3
Yakima River: Richland, Wash	6	10	16	—	—	—
Yellowstone River: Sidney, Mont	21	2	23	—	—	—

on weekly composited samples. Beginning in September 1961, alpha determinations have been made on one sample each month, and beta determinations have generally been made on weekly samples. For the first operating year of each new station, sampling, and alpha and beta analysis are done weekly.

If at any time activity significantly greater than the normal environmental levels has been noted, the rate of sampling and analysis has been increased to at least one every week. Since January 1959, a portion of each sample from all stations in the network has been composited into a three-month station sample for measurement of strontium–90 (*7*).

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(*2*) Division of Water Supply and Pollution Control, Public Health Service: *National Water Quality Network Annual Compilation of Data*, PHS Publication No. 663, 1960 Edition, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

(*3*) Setter, L. R., and S. L. Baker: Radioactivity of Surface Waters in the United States, *Radiological Health Data, 1*:20–31 (October 1960).

(*4*) Straub, C. P.: Significance of Radioactivity Data. *Journal of the American Water Works Association, 53*:704 (June 1961).

(*5*) Setter, L. R., J. E. Regnier, and E. A. Diephaus: Radioactivity of Surface Waters in the United States, *Journal of the American Water Works Association, 51*:1377 (November 1959).

(*6*) Robert A. Taft Sanitary Engineering Center, Public Health Service: *Radionuclide Analysis of Environmental Samples*, Technical Report R59–6 (November 16, 1959).

(*7*) Straub, C. P., L. R. Setter, A. Goldin, and P. F. Hallbach: Strontium–90 in Surface Waters in the U.S., *Journal of the American Water Works Association, 52*:756 (June 1960).

Radioactivity in Drinking Water, 1961

DRINKING WATER ANALYSIS PROGRAM

Division of Environmental Engineering and Food Protection, and
Division of Radiological Health, Public Health Service

The responsibility of the Public Health Service for the certification of drinking water supplies used by interstate common carriers has led to an extensive drinking water analysis program, initiated in November 1960. The analysis program, which is under the Service's Interstate Carrier Branch, is planned to ultimately cover the 850 U.S. water supplies serving interstate carriers.

Figure 1 shows the nationwide distribution of the 139 municipalities included in the first sampling, which was concluded in October 1961. In many instances, there are several sources for a municipality and each is sampled. A second sampling at these same cities is under way at present.

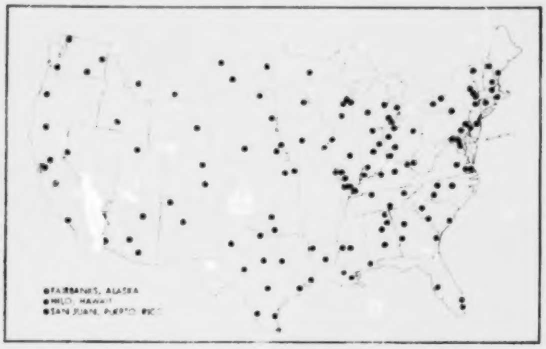

FIGURE 1.—DRINKING WATER ANALYSIS PROGRAM SAMPLING STATIONS

The drinking water standards for radionuclides (*1*) are conservative in their requirements so that the total intake of these nuclides from all sources is not likely to result in an intake greater than that recommended by the Federal Radiation Council (*2*). The standards provide for the approval of water supplies, based on their radionuclide content, when the water does not contain more than 3 μμc/liter of radium-226 or 10 μμc/liter of strontium-90. In the absence of strontium-90 (much less than 10 μμc/liter) and in the absence of alpha emitters (much less than 3 μμc/liter) the water supply is acceptable when the gross beta concentration does not exceed 1000 μμc/liter.

However, a water supply may be approved when the limits prescribed above are exceeded if it can be demonstrated by surveillance that the total intake of radioactivity from all sources is within the limits recommended by the Federal Radiation Council for control action. When mixtures of radionuclides are present, the proportion of each radionuclide to its maximum limit should be considered when evaluating the exposure.

The determinations performed on the selected carrier supplies are sanitary chemical analyses, carbon chloroform analyses, spectrographic examinations, certain quantitative chemical analyses, and radiochemical analyses. Each sample to be analyzed for radionuclides consists of a composite of three aliquots a day obtained over a two-week period. The analyses for gross alpha, gross beta, and strontium-90 are performed at the Southeastern, Northeastern, and Southwestern Radiological Health Laboratories, operated by the Division of Radiological Health.

Table 1 presents data from the 1961 sampling not previously published in *Radiological Health Data.* In table 2 the same data are arranged to facilitate rapid visual comprehension. Each item is shown in terms of its nationwide frequency distribution, range and mean. Also presented are the Drinking Water Standard limit, the total number of supplies which provide the data, and the number of "less than" (<) values. These data show that water from the majority of supplies contains radioactivity well below the acceptable limit.

Due to the limitation of analytical methods, it is often necessary to show a result as being "less than" a stated value. In statistically treating the data, the full "less th[illegible]lue is used. The effect of this is to place a[illegible]pper limit on the results which is quite satisfactory for surveillance and control action.

TABLE 1.—RADIOACTIVITY IN DRINKING WATERS (1961)

[Concentrations in μμc/liter]

Station location		Population served	Date sampled	Sr^{90}	Alpha activity			Beta activity		
City	State			Total solids	Suspended	Dissolved	Total[a]	Suspended	Dissolved	Total[a]
Birmingham	Ala.									
Shades Plant		600,000	10/ 4–10/18					<3.0	3.7	<6.7
Putnam Plant		—	10/ 4–10/18					<3.0	<3.0	<6.0
Gadsden	Ala.	600,000	9/25–10/10	1.8				<3.0	<3.4	<6.4
Tucson	Ariz.									
Sampling Point No. 1		223,000	5/ 1– 5/16							
Sampling Point No. 2		—	6/ 8– 6/21		<0.5	3.5	<4.0	<1.0	5.0	<6.0
Sampling Point No. 3		—	5/17– 6/ 1							
Winslow	Ariz.	9,000	5/16– 5/31							
Fresno	Calif.	150,000	10/ 2–10/18					2.3	3.5	5.8
Los Angeles	Calif.									
L.A. Rv. Conduit Sys		2,510	8/28– 9/12							
Lower Van Norman Res		—	7/ 6– 7/20							
Eagle Rock Res		—	7/26– 8/ 9							
Foot Hill Pump Sta		—	8/16– 8/30							
San Pedro Station		—	7/13– 7/27							
Mullholland Res		—	9/14– 9/28							
Martinez	Calif.	15,000	3/ 8– 3/22							
Sacramento	Calif.	181,000	3/ 1– 3/15							
Needles	Calif.	5,000	7/18– 8/ 4		<0.5	<0.5	<1.0	<1.0	8.2	<9.2
Hartford	Conn.	375,000	4/26– 5/10		<5.0	<5.0	<10.0	<3.0	<3.0	<6.0
Wilmington	Del.									
Porter Filter Plant		156,000	2/13– 3/ 1			<0.5			<2.6	
Brandywine Filter Plt		156,000	11/ 7–11/21					<3.0	7.2	<10.2
Washington	D.C.									
Dalecarlia Plant		1,100	10/11–10/26					<3.0	7.5	<10.5
McMillan Plant		1,100	10/11–10/28					<3.0	6.1	<9.1
Hilo	Hawaii	25,000	4/19– 5/ 4							
Burlington	Iowa	35,000	10/24–11/ 7							
Des Moines	Iowa	234,000	11/ 1–11/17						11.4	
Lexington Main Plant	Ky.	125,000	1/23– 2/ 7			<0.5			<2.6	
Alexandria	La.	50,000	8/ 8– 8/21					<3.0	<3.0	<6.0
Baton Rouge	La.	200,000	8/ 9– 8/31					<3.0	<3.0	<6.0
New Orleans	La.	600,000	8/10– 8/24					<3.0	3.9	<6.9
Hagerstown	Md.									
Potomac River Station		—	10/ 9–10/25					<3.0	6.0	<9.0
Bay City	Mich.	70,000	9/14– 9/29					<3.0	4.4	<7.4
Muskegon	Mich.	62,000	9/12– 9/27					<3.0	7.6	<10.6
Sault Ste. Marie	Mich.	20,000	9/13– 9/29					<3.0	5.4	<8.4
Cape Girardeau	Mo.	25,000	1/ 3– 1/17							
St. Louis	Mo.									
Howard Bend Plant		250,000	12/ 5–12/19/60							
Chain of Rocks Plant		250,000	3/27– 4/10							
Grand Forks	N. Dak.	34,000	11/ 9–12/ 1		1.1	6.4	7.5	0.8	12.5	13.3
Lincoln	Nebr.	129,000	10/24–11/ 8					1.2	18.6	19.8
Omaha	Nebr.	400,000	2/13– 2/27							
Reno	Nev.	50,000								
Berlin	N. H.	17,000	5/ 1– 5/13		<0.5	<0.5	<1.0	<3.0	<1.0	<4.0
Manchester	N. H.	92,000	5/ 3– 5/17		<0.5	<0.5	<1.0	<3.0	4.4	<7.4
Trenton	N. J.	200,000	10/ 2–10/16					<3.0	10.0	<13.0
Albuquerque	N. Mex.	214,000	6/ 6– 6/21		<0.5	2.2	<2.7	<1.0	4.8	<5.8
Farmington	N. Mex.	24,000	6/ 7– 7/ 3							
New York City	N. Y.									
Jamaica, W.S. Co.		600,000	10/16_11/ 3					<3.0	3.4	<6.4
Woodhaven Water Co.		150,000	10/30–11/14					<3.0	3.2	<6.2
Poughkeepsie	N. Y.	40,000	9/12– 9/26					<3.0	3.4	<6.4
Rochester										
Lake Hemlock Source		250,000	9/13– 9/27	3.3				<3.0	3.7	<6.7
Lake Ontario Source		42,000	9/13– 9/26					<3.0	5.4	<8.4
Monroe Co. Water Auth		30,000	9/14– 9/27	<1.0				<3.0	4.6	<7.6
Schenectady	N. Y.	112,000	9/28–10/10						<3.0	
Troy	N. Y.	73,000	9/27–10/12					<3.0	<3.0	<6.0
Cincinnati	Ohio	750,000	3/13– 3/29		<0.5	<0.5	<1.0	<3.0	<3.0	<6.0
Lima	Ohio	58,000	3/16– 3/30		<0.5	<0.5	<1.0	<3.0	4.6	<7.6
Springfield	Ohio	90,000	3/15– 3/30		<0.5	<0.5	<1.0	<3.0	<3.0	<6.0
Oklahoma City	Okla.									
Lake Hefner		310,000	2/ 9– 2/25	1.2		6.0			5.7	
Lake Overholser		310,000	5/25– 6/ 8		<0.5	<0.5	<1.0	<3.0	6.2	<9.2
Eugene	Ore.	62,000	10/24–11/ 9						1.4	
Allentown	Pa.	112,000	6/ 1– 6/15		<0.5	<0.5	<1.0	<3.0	<3.0	<6.0
Philadelphia	Pa.									
Torresdale Plant		1,000,000	1/30– 2/14			<0.5			<2.6	
Providence	R. I.	383,000	3/27– 4/10						<3.0	
Brownwood	Tex.	18,000	4/24– 5/ 9	<1.0	<0.5	<0.5	<1.0	<3.0	7.0	<10.0
Corpus Christi	Tex.									
Cunningham Plant		198,000	3/28– 4/13		<0.5	<0.5	<1.0	<3.0	5.6	<8.6
Stephens Plant		—	4/ 5– 4/19	<1.0	<0.5	<0.5	<1.0	<3.0	6.2	<9.2
Galveston	Tex.	71,000	7/18– 8/ 3					<3.0	<3.0	<6.0
Laredo	Tex.	118,000	4/26– 5/25		<0.5	<0.5	<1.0	<3.0	4.3	<7.3
Lubbock	Tex.	128,000	2/28– 3/16		<0.5	<0.5	<1.0	<3.0	12.8	<15.8
Port Arthur	Tex.	90,000	7/19– 8/ 2					<3.0	3.5	<6.5
San Angelo	Tex.	60,000	4/25– 5/ 9		<0.5	<0.5	<1.0	<3.0	<3.0	<6.0
San Antonio	Tex.	517,000	2/21– 3/10		<0.5	<0.5	<1.0	<3.0	<3.0	<6.0
Waco	Tex.	100,000	5/25– 6/ 9		<0.5	<0.5	<1.0	<3.0	3.5	<6.5
Wichita Falls	Tex.	101,000	5/26– 6/10		<0.5	<0.5	<1.0	<3.0	3.5	<6.5

TABLE 1.—RADIOACTIVITY IN DRINKING WATERS (1961)—Continued

[Concentrations in $\mu\mu c$/liter]

Station location		Population served	Date sampled	Sr^{90}	Alpha activity			Beta activity		
City	State			Total solids	Suspended	Dissolved	Total[a]	Suspended	Dissolved	Total[a]
Portsmouth	Va.	—	8/21– 9/ 7					35.0	10.0	45.0
Richmond	Va.	—	12/ 6–12/21					<3.0	10.0	<13.0
Burlington	Vt.	45,000	1/11– 1/25	1.9	<0.5	<0.5	<1.0	<2.6	2.9	<5.5
Bellingham	Wash.									
Lake Whatcomb		39,000	2/ 7– 2/21							
Lake Padden		—	2/22– 3/ 8							
Longview	Wash.	32,000	1/17– 1/31							
Pasco	Wash.	14,000	6/ 5– 6/19							
Spokane	Wash.	182,000	7/26– 8/10		<0.5	<0.5	<1.0	2.3	5.7	8.0

[a] Where "less than" values comprise more than 10 percent of the total, the "less than" sign (<) is shown with the total.

TABLE 2.—ACTIVITY IN DISSOLVED SOLIDS OF INTERSTATE CARRIERS WATER SUPPLIES (1961)

Strontium-90 activity	Beta activity	Alpha activity
Range from 0.1 to 3.3 $\mu\mu c$/liter	Range from 0.6 to 300.0 $\mu\mu c$/liter	Range from 0.5 to 19.9 $\mu\mu c$/liter
Drinking water standards limit—10 $\mu\mu c$/liter	Drinking water standards limit—1000 $\mu\mu c$/liter	Drinking water standards limit—none except for Ra^{226} (3 $\mu\mu c$/liter)
Arithmetic mean—1.0 $\mu\mu c$/liter	Arithmetic mean—7.2 $\mu\mu c$/liter	Arithmetic mean—1.5 $\mu\mu c$/liter
Total number of supplies—27	Total number of supplies—141	Total number of supplies—80
Number of "less than" values—8	Number of "less than" values—56	Number of "less than" values—70

Interval (pc/liter)	No. of supplies	Interval (pc/liter)	No. of supplies	Interval (pc/liter)	No. of supplies
0.0–0.2	4	0.0– 1.9	4	0.0–0.1	0
0.3–0.5	4	2.0– 2.9	16	0.2–0.3	0
0.6–0.8	4	3.0– 3.9	67	0.4–0.5	69
0.9–1.1	10	4.0– 4.9	12	>0.5	11
1.2–1.4	1	5.0– 5.9	10		
1.5–1.7	0	6.0– 6.9	11		
1.8–2.0	2	7.0– 7.9	4		
2.1–2.3	0	8.0– 8.9	1		
2.4–2.6	0	9.0– 9.9	1		
2.7–2.9	0	10.0–10.9	3		
>2.9	2	11.0–11.9	2		
		12.0–12.9	3		
		13.0–13.9	1		
		14.0–14.9	1		
		15.0–15.9	1		
		>15.9	4		

REFERENCES

(1) Federal Register Rules and Regulations: *Title 42 Public Health Chapter 1, Public Health Service*, Department of Health, Education, and Welfare; Part 72, *Interstate Quarantine, Subpart J, Drinking Water Standards*, pp. 2154–5, (March 6, 1962).

(2) Federal Radiation Council: *Background Material for the Development of Radiation Protection Standards, Report No. 2*, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (September 1961), price 20 cents.

Previous coverage in *Radiological Health Data:*

Period	Issue
1960 and 1961	*May 1962*
1960 and 1961	*August 1962*
1960 and 1961	*October 1962*

RADIOSTRONTIUM IN TAP WATER[1]
March–June 1962

Health and Safety Laboratory
U.S. Atomic Energy Commission

The Health and Safety Laboratory has performed analyses for strontium–90 concentrations in tap water at New York City since August 1954 and at Richmond, California since April 1958. Each sample analyzed is a monthly composite of daily sampies. Also, determinations for strontium–89 have been made since September 1961.

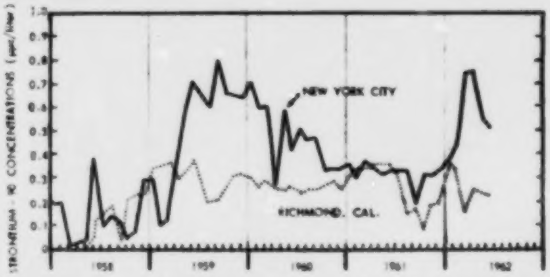

FIGURE 2.—STRONTIUM–90 CONCENTRATIONS IN TAP WATER

Data for the past several years are plotted in figure 1. Data prior to 1958 appear in an earlier HASL report.[2] Strontium–90 concentrations and strontium–89/strontium–90 ratios for March through June 1962 appear in table 1.

TABLE 1.—RADIOSTRONTIUM IN TAP WATER

Month	New York City[a]		Richmond, California[b]	
	Sr^{90} (μμc/liter)	Sr^{89}/Sr^{90} [c]	Sr^{90} (μμc/liter)	Sr^{89}/Sr^{90} [c]
1959 Average	0.40		0.29	
1960 Average	0.47		0.26	
1961 Average	0.32		0.25	
1962 March	0.73	3.1	0.14	20.3
April	0.74	7.7	0.25	9.2
May	0.54	4.0	0.23	4.2
June	0.51	3.8	0.22	4.6

[a] From 100–200 liters per sample.
[b] Approximately 100 liters per sample.
[c] Strontium–89 extrapolated to midpoint of sampling period.

The strontium–90 concentrations for New York City reached their peak during March and April 1962 and are now declining. Although Richmond did not report as high strontium–90 concentrations as New York City, the higher strontium–89/strontium–90 ratios in Richmond during January through April 1962 indicate that the fallout was of more recent origin there.

Previous coverage in *Radiological Health Data*:

Period	Issue
First quarter 1961	*December 1961*
Second quarter 1961	*March 1962*
Third and fourth quarters 1961	*June 1962*
January–April 1962	*September 1962*

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[1] U.S. Atomic Energy Commission: *Fallout Program Quarterly Summary Report, HASL–127*, Office of Technical Services, Department of Commerce, Washington 25, D.C. (July 1, 1962), price $3.00.

[2] U.S. Atomic Energy Commission: *Environmental Contamination from Weapons Tests, HASL–42*, Office of Technical Services, Department of Commerce, Washington 25, D.C. (October 1962), price $3.50.

40

SECTION V.—OTHER DATA

Summary of State Dental Radiological Health Activities

James W. Miller[1]

Concern over the possible hazards from ionizing radiation has caused an increasing awareness by the dental profession of its role in the exposure of the population to X-rays. With this awareness, dental societies have in some cases requested, and in all instances cooperated in, public health programs designed to evaluate the problem and to reduce or eliminate unnecessary radiation exposure from dental sources.

Of the estimated 200,000 X-ray machines in use in this country, approximately 100,000 are owned and operated by dentists. These dentist-operated machines expose about 185,000,000 dental films a year. While the contribution to population exposure doses arising from dental radiography is considerably less than that from medical sources (*1*, *2*), the conservative assumption is that the somatic and genetic effects resulting from radiation insult have no threshold and that a direct linear relationship exists between dose and biological effect (*3*). Thus, in general, any exposure of ionizing radiation to an individual or population group is potentially hazardous, and the benefits resulting from an exposure of X-rays must be weighed by the risk involved. No matter how small the present radiation exposure is to the patient or to the occupationally exposed person, if it can be reduced, every reasonable effort should be made to reduce this exposure.

Studies conducted in larger centers of population by interested parties and agencies following the 1956 report of the National Academy of Sciences (*4*) indicated that a large percentage of the dental X-ray machines in this country did not meet recommendations set forth by the National Committee on Radiation Protection and Measurements (*5*) or the recommendations of the American Academy of Oral Roentgenology (*6*).

On the basis of these findings, dental radiological health programs were established in many State health departments.

Survey of Dental Radiological Health

The types of dental radiological health programs that have been or are being conducted nationally by health departments were ascertained by a Public Health Service survey[2] of each of the fifty States, the District of Columbia and Puerto Rico. Inquiries were made about their activities and accomplishments in dental radiological health. The information requested pertained primarily to the areas of legislation, regulations, inspection, correction, and education. Information was obtained from all fifty States, the District of Columbia and Puerto Rico.

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[1] Dr. Miller is Project Officer, Dental Radiological Health Project, State Assistance Branch, Division of Radiological Health, Public Health Service.

[2] Conducted by Division of Radiological Health, Public Health Service. The data under discussion are valid as of December 1, 1962.

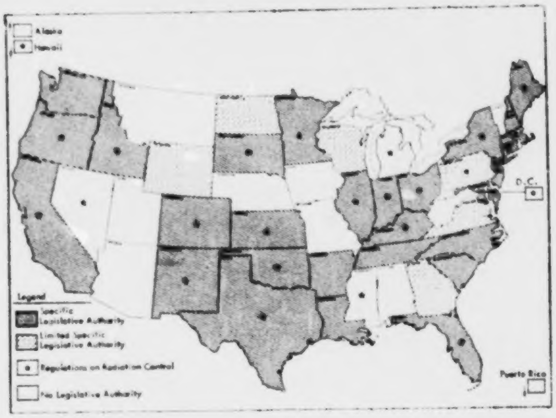
Alaska
Hawaii
D.C.
Legend
Specific Legislative Authority
Limited Specific Legislative Authority
Regulations on Radiation Control
No Legislative Authority
Puerto Rico

Figure 1.—STATES WITH RADIATION CONTROL ACTIVITIES, AS OF DECEMBER 1, 1962

Thirty-six States and the District of Columbia have enacted some type of specific legislation for radiation control activities. The bulk of the legislative action for radiation control has taken place within the past three years. Four other States have adopted radiation control regulations under the broad authority of the department of health. Thus, a total of forty States and the District of Columbia have adopted some form of control of radiation sources. About two-thirds of the population in the United States live in these States. Figure 1 shows those States with radiation control activities. The scope of the radiation codes or regulations vary with the State. Some have only industrial codes which do not apply to the licensed art of healing. Codes which include the licensed practitioners of the healing arts do not ordinarily limit the amount of radiation that may intentionally be applied to a person for diagnostic purposes by or under the direction of a dentist. Only ten States have specific requirements for dental X-ray machines and installations. Requirements for dental X-ray installations in these States usually parallel closely the recommendations of the National Committee on Radiation Protection and Measurements (*5*).

Twenty-seven States and the District of Columbia, shown in figure 2, require registration of dental X-ray machines. Approximately 70 percent of the dental X-ray machines in this country are located in these States. Estimates on the probable number of X-ray machines located in a State are based on an average of 1.03 X-ray machines per dentist. This figure has been determined by previous dental X-ray surveys in various parts of the country, although the actual number in a given State may vary from this. The number of dentists in each State is based on figures from the American Dental Association (*7*). A total of 29,228 dental X-ray machines have been registered in seventeen States reporting numbers registered to date.

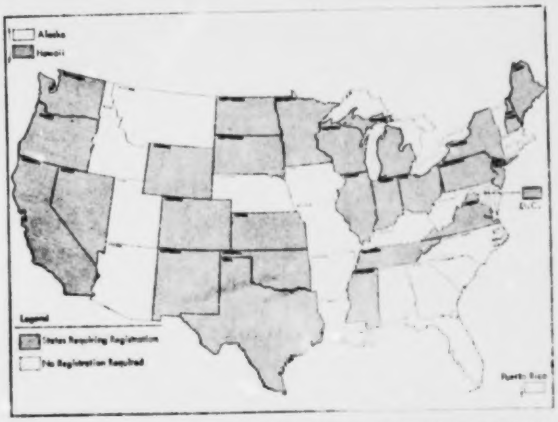

Figure 2.—STATES REQUIRING REGISTRATION OF DENTAL X-RAY MACHINES, AS OF DECEMBER 1, 1962

Inspection programs of dental X-ray equipment and/or installations have been or are now being conducted in forty-nine States. Two survey techniques for the inspection of dental X-ray equipment are generally used. One method of conducting a large scale survey of dental X-ray machines, to determine whether machines have characteristics leading to unnecessary radiation, is the "by mail" Dental Surpak procedure.[3] It is designed to check the size of the beam at the end of the pointer cone, the approximate roentgen output, total filtration (inherent and added), beam symmetry, and leakage radiation in the direction of a patient's face. While this procedure assists materially in indicating the need for reducing unnecessary patient and occupational exposure, it does not completely remove the need for installation inspections. The Surpak does serve, however, as an aid in surveying rural and inaccessible areas, locating priority needs, and as a method of follow-up after recommended improvements reportedly have been made.

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[3] A description of the Surpak may be found on page 46 of this issue.

The other method of conducting a survey of dental X-ray machines is the physical inspection of the dental office. The physical survey usually covers equipment, technique, and occupational exposure. The technique of inspection will depend on the established objectives of the X-ray program.

TABLE 1.—TYPE OF PROGRAM CONDUCTED

Type of Inspection	Number of States[1]
Installation visit only	17
Surpak only	9
Combination of Surpak and other[2]	24
Other only	1
	TOTAL 51

[1] District of Columbia and Puerto Rico counted as States.
[2] Other includes film badge and template.

Of the forty-nine States that have conducted some type of inspection program, seventeen conduct installation visits only, nine have used the Surpak only, and twenty-four plus the District of Columbia and Puerto Rico have or are using a combination of the Surpak with some other method, usually an installation inspection. These data are presented graphically in figure 3 and tabularly in table 1. The estimated number of X-ray inspections conducted by State or local health departments, as shown in table 2, is set at 67,300. While some of these inspections may have been duplications of different inspection methods on the same dental X-ray machine, 67,300 inspections represent a substantial number. These figures do not include studies such as the one reported by Yale (8) or inspections performed by private companies or individuals. Of the thirty States that have used the Surpak in their program, eighteen have completed their initial survey, in the sense that 65 to 95 percent of the dentists cooperated on a voluntary basis. The mode is 80 percent voluntary cooperation on a national basis. Figure 3 shows States with inspection programs.

TABLE 2.—NUMBER OF DENTAL X-RAY INSPECTIONS

Type of Inspection	Number of States	Estimated Number of Inspections
Installation visit	37	26,000
Surpak	30	28,000
Other*	6	3,300
		67,300

* Other includes film badges and template.

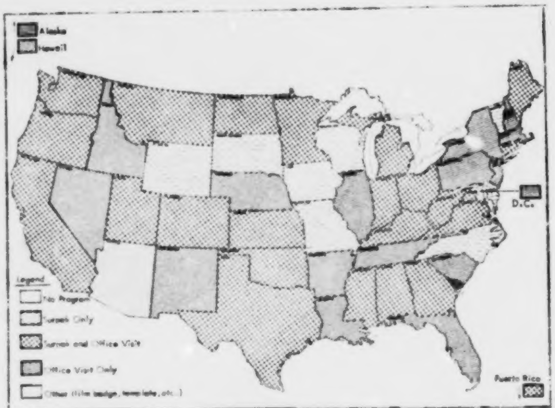

FIGURE 3.—STATES CONDUCTING DENTAL INSPECTION PROGRAMS, AS OF DECEMBER 1, 1962

One State health department, Nevada's, has completed an office visit inspection of every dental X-ray installation within the State. This program was conducted on a voluntary basis. One hundred percent participation is possible with the complete cooperation and support of the State and local dental societies. Three or four other health departments have completed inspections of nearly 100 percent of the dental offices within their States. Dental X-ray installation inspection programs are well underway in many other States.

Although information was sought on the type of correction program for filtration and collimation that is being conducted, this phase of the dental radiological health program has not been actively underway for a sufficient length of time to properly evaluate the number corrected. Experience of the Division of Radiological Health and other investigators indicate that 40 to 75 percent of the X-ray units inspected required additional collimation and filtration to meet recommended standards. The type of correction program and the number of States involved is presented in table 3.

TABLE 3.—FILTRATION AND COLLIMATION CORRECTION PROGRAMS

Type of Program	Number of States*
None	8
Sent to dentist only	2
Installed when inspected only	9
Recommend only	10
Combination of above types	17
	TOTAL 51

*District of Columbia and Puerto Rico counted as States.

Most State dental radiological health programs are conducted in cooperation with other disciplines of the health departments. Only seven States reported that their programs were conducted strictly by the dental section. In fourteen States the dental radiological health activities have been carried on by other disciplines in the health department without the assistance of the dental program. Only one State reported no activity in the dental radiological health area.

TABLE 4.—EDUCATIONAL PROGRAMS CONDUCTED

Response	Number of States
No	10
Yes	34
Planned	5
No Response	3
	TOTAL 52*

*Includes District of Columbia and Puerto Rico.

Table 4 shows the number of States conducting educational programs. It is generally agreed that a certain degree of educational effort is necessary to attain the objective of a program. This is especially true in the area of dental radiological health, where most State programs have been on a voluntary, cooperative basis with the dental profession.

The educational programs being conducted or planned were divided into several categories as presented in table 5. The effectiveness of these educational efforts is difficult to evaluate. One method of evaluation might be the number of dental X-ray machines found in need of filtration or collimation. Based on such a method, educational efforts to date have not been effective, since 40 to 75 percent of the dental X-ray machines inspected still do not meet present-day standards for filtration and collimation.

TABLE 5.—TYPE OF EDUCATIONAL PROGRAM CONDUCTED OR PLANNED

Type	Number of States
A. None	5
B. Not stated	11
C. Education at time of inspection	2
D. Pamphlet only	3
E. Pamphlet plus educational inspection	4
F. Publications in state journal or newsletter	4
G. Combination of talks & film at society meetings plus articles in State journals	13
H. Combination of C & G	7
I. Post-graduate instruction	3
	52*

*Includes District of Columbia and Puerto Rico.

In an attempt to evaluate the dental radiological health programs, information was requested on the planned scope of the States' programs. From the replies received, the scope of the programs was separated into four categories as presented in table 6. From this breakdown, it appears that most of the States have plans for a continuing program of inspection and correction.

Assistance to State Programs From the Public Health Service

Support that States need to carry out their dental radiological health programs is being provided by the Public Health Service's Divi-

TABLE 6.—PLANNED SCOPE OF STATE PROGRAM

Scope	Number of States
No answer	5
Inspection only	5
Inspection plus correction	15
Periodic inspection and correction	10
Continuous program of inspection, correction, and education	17
	TOTAL 52*

*Includes District of Columbia and Puerto Rico.

sion of Radiological Health. Dental personnel from this Division have consulted with and/or assisted in some manner virtually every State health department in this country. Additionally, each of the nine Regional Offices of the Public Health Service is staffed with a program director for radiological health. The program directors are available to individual States for technical consultation and assistance in developing radiological health programs. Also, professional staff members are on loan to State health departments. Some of these personnel have been used in dental X-ray inspection programs.

Thirty-five States have received or are scheduled to receive Surpaks before June 1963. Many other States have expressed an interest in this method of conducting large-scale surveys of dental X-ray machines. A total of 52,000 Surpaks have been requested by State health departments. Up to December 1, 1962, 33 States had received 40,000 of the scheduled Surpaks.

With regard to educational aids, the Public Health Service booklet "Radiation Protection for Dentist and Patient,"* is typical of the type of material being used effectively in these State programs.

Diagnostic X-ray survey kits loaned by the Public Health Service are being used by the States in carrying on their X-ray inspection programs. Filters and collimators to bring the five most common dental X-ray machines found in this country up to recommended standards are also being furnished by the Public Health Service at no charge to the States. Thirty-two States have requested that collimators and filters be made available to them. To date, enough filters and collimators have been sent to State health departments to correct 43,000 dental X-ray machines.

Summary

1. A survey was made of State dental radiological health programs.
2. Thirty-six States have enacted some type of specific legislation for radiation control activities.
3. Twenty-eight States reported that they required registration of dental X-ray machines.
4. Inspection programs of dental X-ray equipment and/or installations have been or are now being conducted in forty-nine States. The estimated number of X-ray machine inspections conducted by State or local health departments is placed at 67,300.

REFERENCES

(1) Lindell, B., and L. R. Dobson: *Ionizing Radiation and Health, World Health Organization Public Health Paper, No. 6*, Geneva (1961).

(2) Committee on Radiological Hazards to Patients: *Radiological Hazards to Patients—Second Report of the Committee*, Her Majesty's Stationery Office, London (1960), price six shillings.

(3) Federal Radiation Council: *Background Material For the Development of Radiation Protection Standards, Report No. 1*, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (May 13, 1960), price 30 cents.

(4) National Academy of Sciences-National Research Council: *The Biological Effects of Atomic Radiation, Summary Reports*, Washington, D.C. (1956).

(5) National Committee on Radiation Protection and Measurements: *Medical X-Ray Protection Up to Three Million Volts, National Bureau of Standards Handbook 76*, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (February 9, 1961), price 35 cents.

(6) Richards, A. G., et al.: X-Ray Protection in the Dental Office, *Journal of the American Dental Association, 56*:514–21 (April 1958).

(7) Bureau of Economic Research and Statistics, American Dental Association: Changes in the Distribution of Dentists, 1956–1960, *Journal of the American Dental Association, 63*:715–20 (November 1961).

(8) Yale, S. H.: A Ten State Study of the Status of Radiation Hygiene in the Dental Office, *Journal of the American Dental Association, 63*:201–10 (August 1961).

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* Public Health Service: *Radiation Protection for Dentist and Patient*, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (May 1962), price 15 cents.

The Dental Surpak Survey Method

Division of Radiological Health, Public Health Service

Of the several methods of conducting large scale radiation surveys of dental X-ray machines which are available to public health agencies, the Surpak is a simplified approach whereby the practicing dentist participates with his health agency in determining whether his X-ray unit has characteristics which contribute to unnecessary radiation exposure.

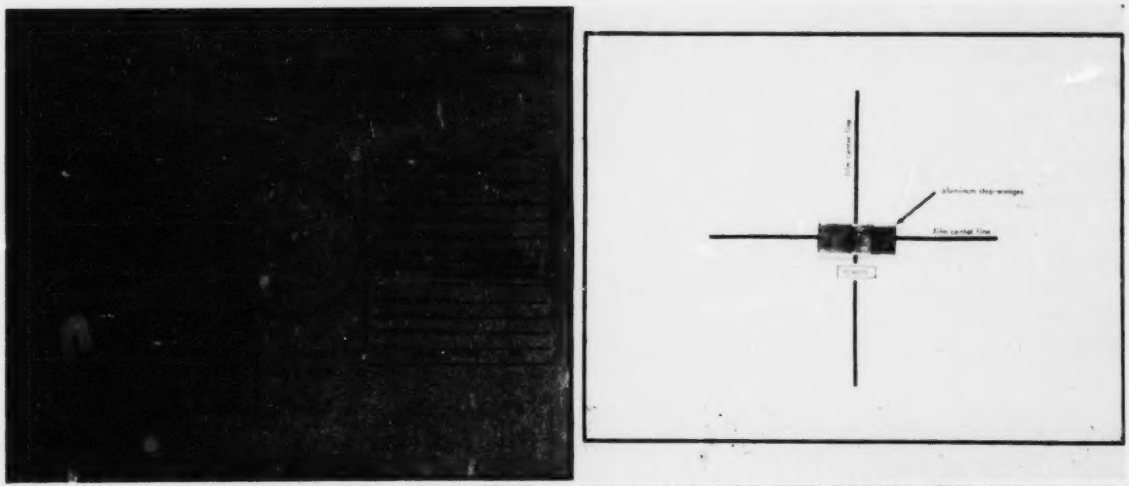
The procedure is useful primarily in assessing factors which affect X-ray exposures of dental patients. However, since many of the factors which affect patient X-ray doses are related in part to the radiation exposures in the immediate vicinity of the machine, the procedure may provide a clue to the occupational doses of the dentist and his assistant. While this method assists materially in indicating the need for reducing unnecessary patient and occupational exposure, it will not completely remove the need for a physical inspection. In addition, it can serve as an aid in surveying rural and inaccessible areas, locating priority needs, and as a method of follow-up and evaluation after recommended improvements reportedly have been made.

The complete Surpak consists of three parts:

1. A mailing envelope. This envelope has the health agency's address imprinted in the upper left-hand corner.
2. A return-mail envelope. This envelope has the health agency's address imprinted in the center of the face of the envelope.
3. The Surpak itself in a sealed envelope. On the face of this envelope will be found a code number, general instructions, and spaces to be filled in by the dentist in reference to his particular X-ray machine(s) (see figure 1).

The general instructions direct the dentist to lay the film envelope on a flat horizontal surface with the face up, aim the pointer cone directly down on the Surpak with the end of the cone touching the center of the circle on the envelope, expose according to one of the printed schedules on the envelope, and return in the envelope provided. The spaces to be filled in are labeled location (county and city), manufacturer, model number, tube housing serial number, console serial number, and data for this exposure (pointer cone used, kilovolt peak, tube current, exposure time, and date).

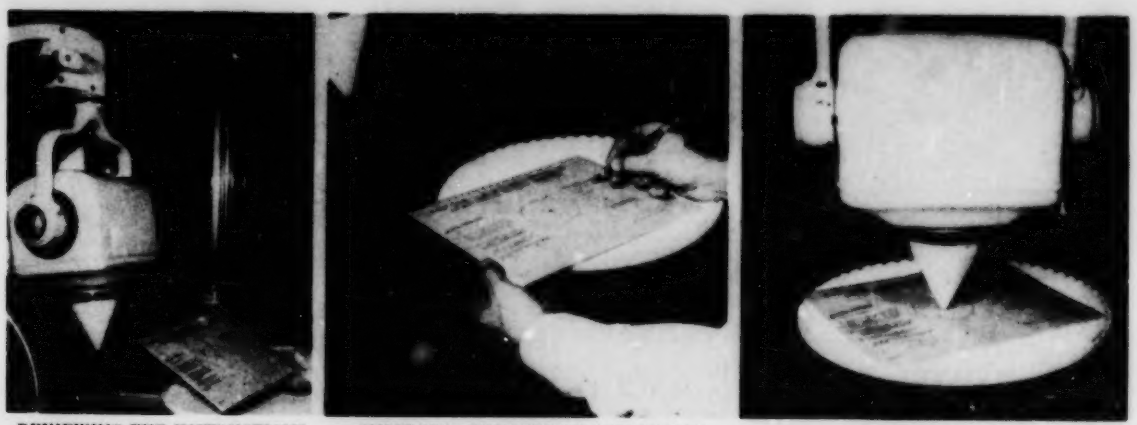
The name and address of the dentist appears nowhere on any Surpak. The sealed Surpak envelope contains a lead backing and an 8″ x 10″ slow industrial-type X-ray film on which



DENTAL SURPAK ENVELOPE SHOWING INSTRUCTIONS, CODE NUMBER, AND SPACES TO BE FILLED IN

SURPAK TEST FILM WITH IDENTIFICATION NUMBER AND ALUMINUM STEP WEDGES, LOCATED ON FILM CENTER

FIGURE 1.—THE DENTAL SURPAK KIT AS MAILED TO PARTICIPATING DENTISTS



REVIEWING THE INSTRUCTIONS SUPPLYING EXPOSURE INFORMATION EXPOSING THE FILM

FIGURE 2.—RECOMMENDED PROCEDURE FOR USING THE DENTAL SURPAK

ACCEPTABLE (DIAMETER 3 INCHES OR LESS) UNACCEPTABLE (DIAMETER GREATER THAN 3 INCHES) EXTREME

FIGURE 3.—EXAMPLES OF BEAM SIZES OBSERVED DURING THE SURPAK SURVEY

is mounted an aluminum step-wedge and a lead code number (see figure 1). The health agency assigns a code number to each participating dentist and mails a complete Surpak to him. The dentist, in turn, fills in the blanks, exposes the Surpak as instructed, and returns it by mail to the health department (see figure 2). This takes just a few moments of his time. The exposed Surpaks are then returned by the health agency to the Public Health Service Radiological Health Laboratory, Rockville, Maryland, for controlled processing and interpretation.*

The Surpak, when properly used, can provide information for a specific X-ray machine about the size of the beam at the end of the pointer cone, the approximate roentgen output in mr/mas, total filtration (inherent and added), beam symmetry, and leakage radiation in the direction of a patient's face.

The beam size can be gaged from the exposed film. Figure 3 shows acceptable (3 inches or less), unacceptable (more than 3 inches), and extreme beam sizes. The extreme beam size is an example of a machine with little or no collimation. The roentgen output and total filtration can be determined from the exposed film with the step-wedges and the information supplied by the participating dentist. The exposed film will also reveal the beam symmetry and leakage radiation in the direction of the patient. Figure 4 shows examples of poor symmetry and good symmetry, while figure 5 shows an example of leakage radiation.

Information obtained from the processed film is then transferred to data processing punch cards from which a list of findings is prepared,

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* Information on obtaining Surpaks or filters and collimators may be obtained from the Division of Radiological Health, Public Health Service.

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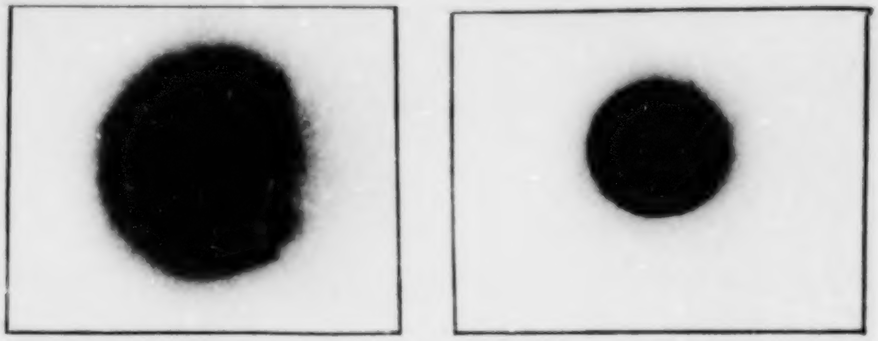


FIGURE 4.—EXAMPLES OF BEAM SYMMETRY: FILM AT LEFT SHOWS POOR BEAM SYMMETRY; FILM AT RIGHT SHOWS GOOD BEAM SYMMETRY

and forwarded back to the local health departments. Each health department in turn notifies the participating dentists of the results obtained and makes recommendations as to whether or not their X-ray machines require corrective procedures to bring them up to recommended standards.

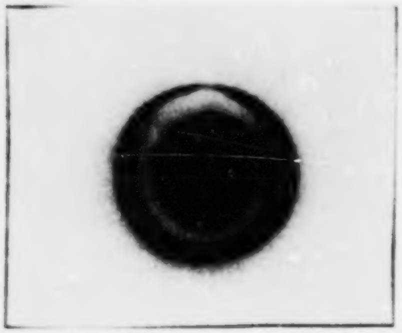
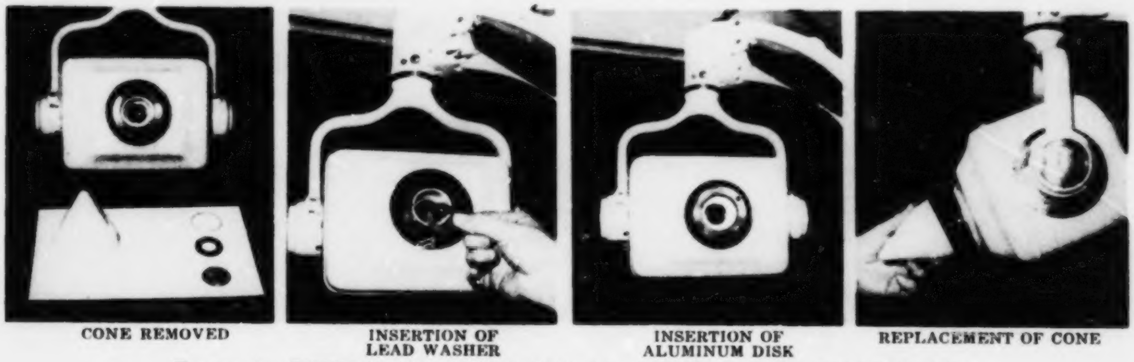


FIGURE 5.—FILM SHOWING EVIDENCE OF LEAKAGE RADIATION AS CONCENTRIC SHADOW AROUND BEAM IMAGE

Partial results from the survey of the 40,000 Surpaks distributed to 33 States indicate that as of November 1962, 40–75 percent of the dental X-ray machines inspected do not meet present-day standards. Of this number, approximately 95 percent can be brought up to approved standards by the insertion of the proper lead collimator and the correct thickness of aluminum filter. Figure 6 illustrates a typical installation of the collimator and filters. As can be seen, this is a relatively simple and easy procedure. With the insertion of the proper collimator and filters, appreciable reduction of unnecessary radiation exposure of the population from dental X-ray machines may be achieved. Two-fold to 100-fold reductions in the radiation exposure of certain tissues of patients' faces may be achieved.

Many State health departments have established standards for dental X-ray machines. In general, these standards include a 2.75—3-inch beam diameter at the tip of the pointer cone and a 1.5—2 mm aluminum equivalent of total



CONE REMOVED

INSERTION OF LEAD WASHER

INSERTION OF ALUMINUM DISK

REPLACEMENT OF CONE

FIGURE 6.—TYPICAL INSTALLATION OF A FILTER AND COLLIMATOR

filtration for equipment operating up to 70 kvp, or *2.5 mm aluminum equivalent* of total filtration for units capable of operating above 70 kvp. These standards are based upon recommendations of the National Committee on Radiation Protection and Measurements (*1*) and the American Academy of Oral Roentgenology (*2*).

REFERENCES

(*1*) National Committee on Radiation Protection and Measurements: *Medical X-ray Protection Up to Three Million Volts, National Bureau of Standards Handbook 76*, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (February 9, 1961), price $0.25.

(*2*) Richards, A. G., et al.: X-Ray Protection in the Dental Office, *Journal of the American Dental Association, 56*:514–21 (April 1958).

Volume of X-Ray Visits[1]

July 1960–June 1961

U.S. National Health Survey, Public Health Service

In order to determine the average X-ray dose in the United States, the number of X-ray visits for various population groups becomes an important factor in dose calculations. Recognizing the importance of medical and dental X-ray exposures in the total radiation dosage to the average person, the U.S. National Health Survey, starting in July 1960, undertook a 12-month household interview survey of medical and dental X-ray visits. The results of the survey are based on estimates of 85,303,000 visits for medical treatment or diagnosis by X-ray and on 49,768,000 dental X-ray visits in a national sample (from July 1960 through June 1961) survey.

I. Limitations of Data

Some limitations of the data should be briefly mentioned in this abstract. The data were obtained from a probability sample of approximately 38,000 households, and are subject to sampling errors. No attempt was made to obtain the number of exposures; therefore, the term "X-ray visit" may include more than one exposure for fluoroscopy, film exposure, or therapy. Visits for radioisotope treatment were not included in the scope of the survey. The data were tabulated by six general areas (chest, lower abdomen, upper abdomen, extremities, head and neck, and skin). This was done because of the inability of some respondents to report specific bones, organs, or types of X-ray procedure. An overall limiting factor, as in all interviews, is the difficulty which respondents have in recalling events over a long span of time. The extent of this bias was reduced by using a 3-month recall period. The average annual volume of visits was received from the 3-month reference period data.

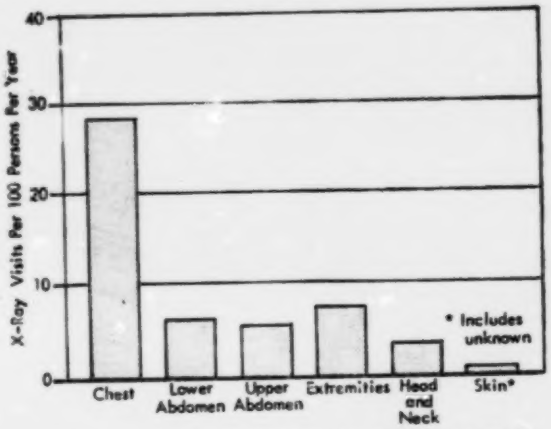


FIGURE 1.—DISTRIBUTION OF BODY AREAS X-RAYED, JULY 1960–JUNE 1961

II. Results and Discussion[*]

A. *Medical X-Ray Visits*

1. *Area of Body X-Rayed*: Figure 1 shows the distribution of body areas X-rayed. The data are also represented in table 1. In general, there was little difference between men and women in volume and rate of X-rays of all areas of the body. However, men, especially those in the 45–64 age group, were somewhat higher in volume and rate of chest X-rays. X-

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[1] Summarized from *Health Statistics—Volume of X-Ray Visits, July 1960–June 1961*, Public Health Service Publication No. 584–B38, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (October 1962), price 40 cents.

[*] *Editor's note: Data on socio-economic factors were also collected by the U.S. National Health Survey, but are not presented herein.*

TABLE 1.—AREA OF BODY X-RAYED DURING VISIT, JULY 1960—JUNE 1961

Sex and age	All medical X-ray visits [1]	Area of body X-rayed					
		Chest	Lower abdomen	Upper abdomen	Extremities	Head and neck	Skin [2]
	Number of medical X-ray visits in thousands						
Both sexes							
All ages	85,303	51,084	11,119	9,969	13,610	5,972	1,000
Under 15	9,403	3,912	818	378	3,399	1,208	(*)
15–29	19,418	12,576	1,752	1,637	3,225	1,117	(*)
30–44	22,044	14,013	2,584	2,828	2,674	1,384	(*)
45+	34,439	20,582	5,966	5,126	4,312	2,172	(*)
45–64	25,852	15,461	4,090	3,909	3,191	1,632	(*)
65+	8,587	5,121	1,876	1,217	1,121	540	(*)
Male							
All ages	43,063	25,808	4,897	4,494	7,581	2,879	497
Under 15	5,308	2,115	(*)	(*)	2,072	805	(*)
15–29	9,463	5,802	766	585	2,285	424	(*)
30–44	10,891	6,963	1,153	1,293	1,519	555	(*)
45+	17,401	10,987	2,656	2,443	1,704	1,094	(*)
45–64	13,345	8,299	2,010	1,870	1,386	825	(*)
65+	4,057	2,688	646	574	(*)	(*)	(*)
Female							
All ages	42,240	25,216	6,222	5,475	6,028	3,092	502
Under 15	4,095	1,797	496	(*)	1,326	493	(*)
15–29	9,954	6,774	986	1,052	940	692	(*)
30–44	11,153	7,050	1,431	1,535	1,154	829	(*)
45+	17,037	9,595	3,310	2,683	2,607	1,078	(*)
45–64	12,507	7,161	2,080	2,040	1,806	807	(*)
65+	4,530	2,434	1,229	643	802	(*)	(*)
	Number of medical X-ray visits per 100 persons per year						
Both sexes							
All ages	47.9	28.7	6.2	5.6	7.6	3.4	0.6
Under 15	16.4	6.8	1.4	0.7	5.9	2.3	(*)
15–29	57.1	37.0	5.2	4.8	9.5	3.3	(*)
30–44	63.0	40.0	7.4	8.1	7.6	4.0	(*)
45+	66.5	39.7	11.5	9.9	8.3	4.2	(*)
45–64	71.2	42.6	11.3	10.8	8.8	4.5	(*)
65+	55.4	33.0	12.1	7.8	7.2	3.5	(*)
Male							
All ages	49.7	29.9	5.7	5.2	8.8	3.3	0.6
Under 15	18.2	7.3	(*)	(*)	7.1	2.8	(*)
15–29	58.4	35.8	4.7	3.6	14.1	2.6	(*)
30–44	64.9	41.5	6.9	7.7	9.1	3.3	(*)
45+	71.2	45.0	10.9	10.0	7.0	4.5	(*)
45–64	76.3	47.5	11.5	10.7	7.9	4.7	(*)
65+	58.4	38.7	9.3	8.3	(*)	(*)	(*)
Female							
All ages	46.2	27.6	6.8	6.0	6.6	3.4	0.5
Under 15	11.6	6.4	1.8	(*)	4.7	1.8	(*)
15–29	55.9	38.0	5.5	5.9	5.3	3.9	(*)
30–44	61.2	38.7	7.9	8.4	6.3	4.5	(*)
45+	62.3	35.1	12.1	9.8	9.5	3.9	(*)
45–64	66.5	38.1	11.1	10.8	9.6	4.3	(*)
65+	53.0	28.5	14.4	7.5	9.4	(*)	(*)

[1] The sum of visits by area of body X-rayed may be greater than the total number of visits, since during one visit more than one area of body may be X-rayed.

[2] Skin includes an estimated 39,000 unknown areas X-rayed.

* Magnitude of the sampling error precludes showing separate estimates.

rays of this area of the body were most frequent in women of the 30–44 age group.

There was a notable difference by age groups of males and females making visits for X-rays of the extremities. Among males the highest rate was found in the 15–29 age group. This has been ascribed as probably due to the high injury rate of males of this age.

A greater number of women than men received X-rays of the lower and upper abdomen and the rate of women making visits for X-rays of the lower abdomen was even greater than visits for X-rays of the extremities. This difference is undoubtedly due to the greater necessity of pelvic examinations for women.

There was little difference between the sexes in the number and frequency of exposures of the head and neck area, and of the skin area.

2. *Place of X-Ray*: Not tabulated in this summary, but included in the original report, are data on the place of X-ray. The majority of X-rays of every area of the body were re-

ceived on visits to a hospital. Outside of hospitals, chest X-rays were most often made in places other than a doctor's office—probably in mobile X-ray units and industrial medical facilities. Only 4.8 percent of X-rays of abdomen and extremities and a negligible amount of head and neck and skin X-rays were given in places other than a hospital or doctor's office.

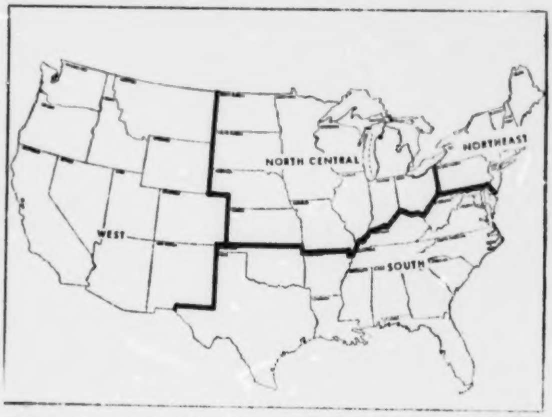

FIGURE 2.—REGIONS OF THE COUNTRY (AFTER BUREAU OF THE CENSUS)—WEST INCLUDES ALASKA AND HAWAII

3. *Regional Distribution*: The survey also included a breakdown into regional groups of persons making X-ray visits. The regions used are those of the Bureau of the Census, as shown in figure 2. Table 2 shows that the largest number of visits were made by men of the North Central section of the country and by women from the South. North Central area women and Southern men were next in number of visits. Both sexes of the Northeast and West were next and last, respectively, in number of visits.

The rate of visits, however, was highest for those in the West. Next highest rate was for North Central males and Southern females and then for Southern males and North Central females. Residents of the Northeast region reported the lowest rate of medical X-ray visits.

In general, both men and women of ages 45–64 had the highest rate of medical X-ray visits in each of the four regions of the country. The only exception was a high rate of visits among males aged 15–29 in the Western region.

4. *Residential Distribution*: The National Health Survey also revealed differences in number of X-ray visits according to residence, as demonstrated in table 3. Volume of visits was highest for men and women living inside urbanized areas. Rural nonfarm residents and then residents of "other urban places" were the groups next in number of visits. The number of visits by rural farm residents was very much lower than the number of visits made by residents of other areas.

In terms of rate of visits, residents inside urbanized areas were again ahead of other groups. Second in number of visits, rural nonfarm women were also next highest in rate of visits. However, "other urban" male residents were second highest in rate of visits, while only third highest in number of visits. Male and female rural farm dwellers remained much lower in rate as well as volume of visits for medical X-ray.

For the most part, men and women in the 45 years and up age group were highest in number and rate of visits. An exception was the rate for rural farm males, where the 30–44 age group made visits most frequently. Among rural nonfarm women, the 30–44 age group was highest in both rate and volume of visits.

B. *Dental X-Ray Visits*

1. *Regional Distribution*: Table 4 shows the regional distribution of dental X-ray visits. Males under 15 and females aged 15–29 from the Northeast were highest in number of dental X-ray visits. Males under 15 from the West and females aged 15–29 from the North Central region were the second largest groupings. Next in number of visits were North Central males under 15 and Western females aged 15–29. Southerners of each sex made the fewest visits.

In terms of rate of visits there was little difference by sex among the regions. Western men and women most frequently made such visits. Next were Northeastern and then North Central residents. Southerners had the lowest rate as well as lowest number of visits. In most instances, it was the 15–29 age group that had the highest rate. Exceptions were the high rates of 30–44–year–old North Central males and 30–44–year–old Southerners of each sex.

2. *Residential Distribution*: When grouped according to residence, those who live within urbanized areas were shown to be highest in number and rate of dental X-ray visits. In all

TABLE 2.—REGIONAL DISTRIBUTION OF MEDICAL X-RAY VISITS, JULY 1960—JUNE 1961

Sex and age	Region				
	All regions	Northeast	North Central	South	West
	Number of medical X-ray visits in thousands				
Both sexes					
All ages	85,303	20,514	23,544	25,170	16,076
Under 15	9,403	2,178	2,400	2,806	2,018
15–29	19,418	4,316	5,208	5,883	4,011
30–44	22,044	5,236	6,180	6,440	4,189
45 +	34,439	8,784	9,756	10,040	5,859
45–64	25,852	6,567	7,505	7,386	4,395
65 +	8,587	2,217	2,251	2,654	1,465
Male					
All ages	43,063	10,399	12,389	12,265	8,011
Under 15	5,308	1,388	1,361	1,519	1,040
15–29	9,463	1,856	2,708	2,720	2,179
30–44	10,891	2,636	3,198	3,052	2,005
45 +	17,401	4,518	5,122	4,973	2,787
45–64	13,345	3,442	3,947	3,726	2,230
65 +	4,057	1,077	1,175	1,248	557
Female					
All ages	42,240	10,115	11,155	12,905	8,065
Under 15	4,095	791	1,040	1,287	978
15–29	9,954	2,459	2,500	3,163	1,831
30–44	11,153	2,600	2,982	3,388	2,184
45 +	17,037	4,266	4,633	5,067	3,072
45–64	12,507	3,125	3,557	3,660	2,164
65 +	4,530	1,140	1,076	1,407	907
	Number of medical X-ray visits per 100 persons per year				
Both sexes					
All ages	47.9	44.3	47.3	46.4	57.9
Under 15	16.4	15.8	15.0	15.5	21.8
15–29	57.1	51.3	55.9	53.7	75.5
30–44	63.0	53.4	64.5	64.1	75.3
45 +	66.5	61.4	65.9	66.7	76.6
45–64	71.2	66.1	74.4	68.6	79.6
65 +	55.4	50.8	47.6	61.9	68.7
Male					
All ages	49.7	46.7	50.3	46.8	59.6
Under 15	18.2	19.7	16.5	16.5	22.4
15–29	58.4	46.7	59.2	52.3	88.9
30–44	64.9	56.7	67.5	64.6	75.3
45 +	71.2	68.5	72.3	70.5	75.3
45–64	76.3	73.5	80.3	72.4	81.3
65 +	58.4	56.2	54.2	65.3	58.1
Female					
All ages	46.2	42.2	44.4	46.1	56.3
Under 15	14.6	11.8	13.3	14.4	21.3
15–29	55.9	55.3	52.8	54.9	63.9
30–44	61.2	50.5	61.5	63.6	75.2
45 +	62.3	55.4	60.0	63.4	77.8
45–64	66.5	59.5	68.8	65.2	78.0
65 +	53.0	46.6	42.0	59.2	77.3

* Magnitude of the sampling error precludes showing separate estimates.

areas, the 15–29 age group was generally highest in number and rate for both males and females.

Among urban residents, the number of visits was highest in the under 15 age group for males, and in the 15–29 age group for females, while the rate for both sexes was highest in the 15–29 age group.

Among rural residents, the number of visits was highest in the under 15 age group for males, and in the 30–44 age group for females. The rate of visits was highest in the 30–44 age group for males and in the 15–29 age group for females.

III. *Statistical Design*

A multistage probability design was utilized for this study. A sample of 500 was drawn from the 1900 geographically-defined Primary Sampling Units (county, group of contiguous counties, or a standard Metropolitan Statistical Area) of the United States. Within each Primary Sampling Unit are geographically-defined segments containing six households. Each

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TABLE 3.—RESIDENTIAL DISTRIBUTION OF MEDICAL X-RAY VISITS, JULY 1960—JUNE 1961

Sex and age	Residence					
	All areas	Urban			Rural nonfarm	Rural farm
		Total	Inside urbanized areas	Other urban places		
	Number of medical X-ray visits in thousands					
Both sexes						
All ages	85,303	56,593	43,322	13,271	22,190	6,520
Under 15	9,403	5,459	4,137	1,322	3,340	604
15-29	19,418	13,269	9,960	3,308	4,698	1,451
30-44	22,044	13,747	10,574	3,173	6,776	1,521
45+	34,439	24,119	18,651	5,468	7,377	2,943
45-64	25,852	18,103	14,087	4,017	5,501	2,248
65+	8,567	6,016	4,565	1,451	1,876	696
Male						
All ages	43,063	28,472	21,772	6,699	11,062	3,530
Under 15	5,308	3,241	2,491	750	1,777	(*)
15-29	9,463	6,283	4,535	1,747	2,291	890
30-44	10,891	6,850	5,380	1,471	3,184	857
45+	17,401	12,098	9,367	2,731	3,810	1,494
45-64	13,345	9,401	7,453	1,948	2,931	1,013
65+	4,057	2,697	1,914	783	879	481
Female						
All ages	42,240	28,122	21,549	6,572	11,128	2,990
Under 15	4,095	2,218	1,646	572	1,563	(*)
15-29	9,954	6,986	5,425	1,561	2,407	561
30-44	11,153	6,897	5,194	1,703	3,592	665
45+	17,037	12,021	9,284	2,737	3,566	1,450
45-64	12,507	8,703	6,633	2,069	2,570	1,235
65+	4,530	3,319	2,651	668	997	(*)
	Number of medical X-ray visits per 100 persons per year					
Both sexes						
All ages	47.9	53.0	56.0	45.0	44.2	31.1
Under 15	16.4	17.1	18.2	14.5	18.4	8.4
15-29	57.1	63.9	67.2	55.6	50.3	37.3
30-44	63.0	65.7	67.6	60.0	63.9	43.8
45+	66.5	72.4	77.1	60.0	61.1	45.8
45-64	71.2	78.0	81.9	66.8	64.2	49.9
65+	55.4	59.6	65.3	46.9	53.7	36.2
Male						
All ages	49.7	55.9	59.1	47.5	44.7	32.3
Under 15	18.2	20.1	21.7	16.0	19.3	(*)
15-29	58.4	64.1	64.9	62.0	52.6	43.8
30-44	64.9	69.3	72.8	58.9	61.3	50.4
45+	71.2	80.2	85.4	66.5	63.9	44.0
45-64	76.3	87.1	93.1	70.0	67.5	42.9
65+	58.4	62.8	64.5	59.0	54.1	46.5
Female						
All ages	46.2	50.3	53.1	42.8	43.8	29.7
Under 15	14.6	14.2	14.6	12.9	17.5	(*)
15-29	55.9	63.7	69.2	49.9	48.3	30.2
30-44	61.2	62.5	62.9	61.1	66.4	37.5
45+	62.3	66.0	70.2	54.7	58.5	47.7
45-64	66.5	70.0	72.1	64.0	60.8	57.4
65+	53.0	57.3	65.8	37.8	53.3	(*)

* Magnitude of the sampling error precludes showing separate estimates.

week about 120 segments were drawn at random and all household members in each segment were then interviewed.

The design mentioned above allows for pooling of data from week to week into larger samples. Continuous measurement, as well as detailed analysis, was achieved.

By the end of the twelve-month period, approximately 125,000 persons in 38,000 households of 6400 segments were included in the sample. The data were collected by the Bureau of the Census and analyzed by the National Health Survey. The statistics produced were applied to the 1950 decennial population and to age and sex classes for estimation purposes.

Other adjustments were made for nonresponse, type of question asked, measurement error, and rounding off. Further detail is afforded this and other aspects of the survey in the original report.

TABLE 4.—REGIONAL DISTRIBUTION OF DENTAL X-RAY VISITS, JULY 1960—JUNE 1961

Sex and age	Region				
	All regions	Northeast	North Central	South	West
Both sexes	Number of dental X-ray visits in thousands				
All ages	48,768	15,141	11,915	10,241	11,471
Under 15	12,230	3,493	2,875	2,399	3,463
15–29	13,881	4,453	3,603	2,727	3,097
30–44	12,351	3,919	2,989	2,611	2,832
45 +	10,305	3,276	2,448	2,503	2,078
45–64	8,686	2,766	2,103	2,044	1,774
65 +	1,619	511	(*)	459	(*)
Male					
All ages	20,661	6,481	5,000	4,172	5,009
Under 15	5,978	1,810	1,433	1,053	1,681
15–29	5,066	1,557	1,260	1,046	1,213
30–44	5,149	1,605	1,375	1,004	1,165
45 +	4,449	1,508	923	1,069	949
45–64	3,717	1,279	752	851	836
65 +	731	(*)	(*)	(*)	(*)
Female					
All ages	28,106	8,661	6,915	6,069	6,462
Under 15	6,253	1,682	1,442	1,346	1,782
15–29	8,795	2,896	2,334	1,681	1,884
30–44	7,202	2,314	1,614	1,607	1,667
45 +	5,857	1,768	1,525	1,434	1,129
45–64	4,969	1,480	1,351	1,193	938
65 +	888	(*)	(*)	(*)	(*)
Both sexes	Number of dental X-ray visits per 100 persons per year				
All ages	27.4	32.7	24.0	18.9	41.3
Under 15	21.4	25.4	17.9	13.2	37.5
15–29	40.8	52.9	38.7	24.9	58.3
30–44	35.3	40.0	31.2	26.0	50.9
45 +	19.9	22.9	16.5	16.6	27.2
45–64	23.9	27.8	20.9	19.0	32.1
65 +	10.4	11.7	(*)	10.7	(*)
Male					
All ages	23.9	29.1	20.3	15.9	37.2
Under 15	20.5	25.6	17.4	11.4	36.3
15–29	31.4	39.2	27.7	20.1	49.5
30–44	30.7	34.5	29.0	21.3	43.8
45 +	18.2	22.9	13.0	15.1	25.6
45–64	21.3	27.3	15.3	16.5	30.5
65 +	10.5	(*)	(*)	(*)	(*)
Female					
All ages	30.7	36.1	27.5	21.7	45.1
Under 15	22.3	25.1	18.5	15.1	38.7
15–29	49.4	65.2	49.3	29.2	65.8
30–44	39.5	44.9	33.3	30.2	57.4
45 +	21.4	23.0	19.7	17.9	28.6
45–64	26.4	28.3	26.1	21.2	33.8
65 +	10.4	(*)	(*)	(*)	(*)

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* Magnitude of the sampling error precludes showing separate estimates.

Table 5.—RESIDENTIAL DISTRIBUTION OF DENTAL X-RAY VISITS, JULY 1960—JUNE 1961

Sex and age	Residence				
	All areas	Urban			Rural
		Total	Inside urbanized areas	Other urban places	
	Number of dental X-ray visits in thousands				
Both sexes					
All ages	48,768	33,379	26,776	6,603	15,389
Under 15	12,230	7,794	6,275	1,519	4,436
15-29	13,881	10,028	7,808	2,220	3,854
30-44	12,351	7,961	6,532	1,429	4,390
45 +	10,305	7,597	6,161	1,435	2,709
45-64	8,686	6,318	5,169	1,149	2,368
65 +	1,619	1,279	993	(*)	(*)
Male					
All ages	20,661	14,029	11,132	2,898	6,632
Under 15	5,978	3,824	3,112	712	2,153
15-29	5,086	3,725	2,720	1,006	1,361
30-44	5,149	3,312	2,701	612	1,837
45 +	4,449	3,167	2,599	568	1,281
45-64	3,717	2,666	2,190	476	1,051
65 +	731	501	409	(*)	(*)
Female					
All ages	28,106	19,350	15,645	3,705	8,756
Under 15	6,253	3,970	3,163	807	2,283
15-29	8,795	6,302	5,088	1.214	2,493
30-44	7,202	4,649	3,831	818	2,553
45 +	5,857	4,429	3,562	867	1,427
45-64	4,969	3,652	2,979	673	1,317
65 +	888	777	584	(*)	(*)
	Number of dental X-ray visits per 100 persons per year				
Both sexes					
All ages	27.4	31.2	34.6	22.4	21.6
Under 15	21.4	24.5	27.6	16.6	17.5
15-29	40.8	48.3	52.7	37.3	29.1
30-44	35.3	38.1	41.8	27.0	31.2
45 +	19.9	22.8	25.5	15.7	14.6
45-64	23.9	27.2	30.0	19.1	18.1
65 +	10.4	12.7	14.2	(*)	(*)
Male					
All ages	23.9	27.5	30.2	20.5	18.6
Under 15	20.5	23.7	27.1	15.2	16.6
15-29	31.4	38.0	38.9	35.7	21.3
30-44	30.7	33.5	36.6	24.5	26.7
45 +	18.2	21.0	23.7	13.8	13.7
45-64	21.3	24.7	27.4	17.1	15.7
65 +	10.5	11.7	13.8	(*)	(*)
Female					
All ages	30.7	34.6	38.6	24.1	24.7
Under 15	22.3	25.3	28.1	18.2	18.5
15-29	49.4	57.5	64.9	38.8	36.5
30-44	39.5	42.1	46.4	29.3	35.5
45 +	21.4	24.3	26.9	17.3	15.6
45-64	26.4	29.4	32.4	20.8	20.6
65 +	10.4	13.4	14.5	(*)	(*)

* Magnitude of the sampling error precludes showing separate estimates.

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Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission receives from its contractors semiannual reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

Summaries of the environmental radioactivity data for 21 AEC installations have appeared periodically in *Radiological Health Data* since November 1960. Summaries follow for Brookhaven National Laboratory and Rocky Flats Plant.

The measured concentration of a radionuclide in air and water may be compared with the Maximum Permissible Concentration (MPC) of that nuclide as recommended by the National Committee on Radiation Protection and Measurement (NCRP). For the environment near an AEC installation, the applicable MPC's are one-tenth of the occupational MPC values for continuous exposure given in the National Bureau of Standards "Handbook 69." The MPC values applicable to the following reports are given in table 1.

In the following reports, the use of nonspecific terms such as "total activity," "total alpha," and "gross beta" do not in themselves suggest any one MPC value. Often, when concentrations are low, a laboratory will assign an MPC value that is more restrictive than necessary. This avoids the more costly isotopic tests necessary to justify a less restrictive value. References to table 1 will be made to designate the appropriate MPC's reported by the laboratories.

BROOKHAVEN NATIONAL LABORATORY
January–June 1962

Associated Universities, Inc.
Upton, New York

The Brookhaven National Laboratory (BNL) operations may affect the environmental levels of radiation in two ways: (1) by discharge of

TABLE 1.—SELECTED ENVIRONMENTAL MPC VALUES PERTAINING TO AEC INSTALLATION REPORTS IN THIS SUBSECTION

Line no.	Radionuclide or mixture of unknown nuclides	Environmental MPC's	
		Water ($\mu\mu c$/liter)	Air ($\mu\mu c/m^3$)
1	If Sr^{90}, I^{129}, Pb^{210}, Po^{210}, At^{211}, Ra^{223}, Ra^{224}, Ra^{226}, Ac^{227}, Ra^{228}, Th^{230}, Pa^{231}, Th^{232}, and Th-nat are not present [a]	3,000	—
2	If Sr^{90}, Pb^{210}, Ra^{226}, Ra^{228} are not present [a]	600	—
3	If Ra^{226}, Ra^{228} are not present [a]	100	—
4	Mixture of unidentified nuclides	10	0.04
5	If α emitters and Ac^{227} are not present [a]	—	1.0
6	If α emitters and Pb^{210}, Ac^{227}, Ra^{228}, Pu^{241} are not present [a]	—	10
7	If α emitters and Sr^{90}, I^{129}, Pb^{210}, Ac^{227}, Ra^{228}, Pa^{230}, Pu^{241}, Bk^{249} are not present [a]	—	100
8	Argon-41 (immersion)	—	40,000
9	Plutonium-239	5,000	0.06
10	Uranium-natural	20,000	2

[a] "Not present" implies that the concentration of the nuclide is small compared with its appropriate MPC. According to recent AEC regulation (Federal Register, Title 10, Part 20, August 9, 1961), a group of nuclides may be considered not present if the ratio of each nuclide to its appropriate MPC is equal to or less than $\frac{1}{10}$ and if the sum of these ratios for the group in question is equal to or less than $\frac{1}{4}$.

coolant air from the graphite research reactor and (2) by the discharge of low level radioactive liquid wastes into a small stream that forms one of the headwaters of the Peconic River.

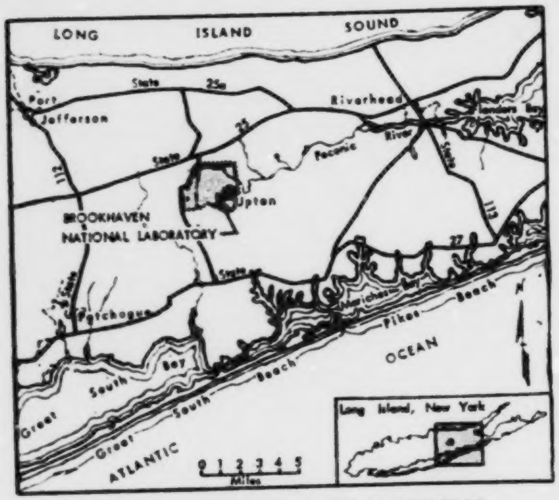
LONG ISLAND SOUND
Port Jefferson
State 25a
Riverhead
25
State
Peconic River
112
BROOKHAVEN NATIONAL LABORATORY
Upton
113
27
State
Patchogue
Great South Bay
Moriches Bay
Pikes Beach
South Beach
OCEAN
ATLANTIC
N
0 1 2 3 4 5
Miles
Long Island, New York

FIGURE 1.—BROOKHAVEN NATIONAL LABORATORY AND SURROUNDING AREA

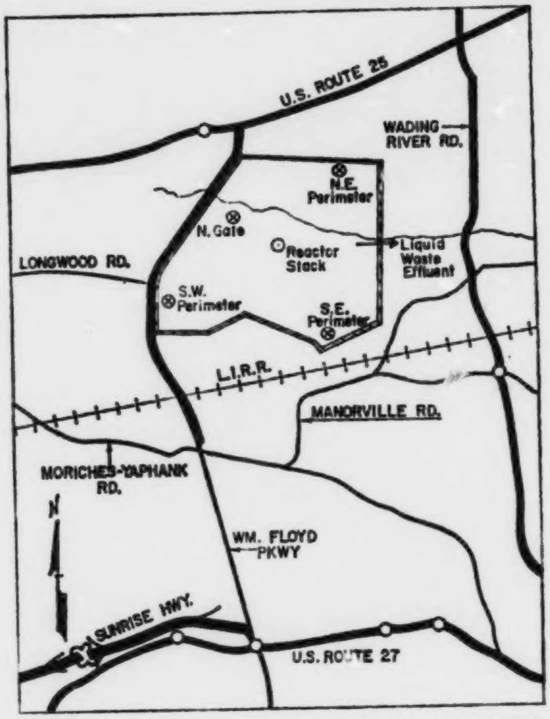
U.S. ROUTE 25
WADING RIVER RD.
N.E. Perimeter
N. Gate
Reactor Stack
Liquid Waste Effluent
LONGWOOD RD.
S.W. Perimeter
S.E. Perimeter
L.I.R.R.
MANORVILLE RD.
MORICHES-YAPHANK RD.
N
WM. FLOYD PKWY
SUNRISE HWY.
U.S. ROUTE 27

FIGURE 2.—BROOKHAVEN NATIONAL LABORATORY MONITORING STATION LOCATIONS

Air Monitoring

The radioactivity in the discharge coolant air is almost entirely that of argon–41, a beta-gamma emitter. Because the most critical exposure to argon–41 is that of external gamma, the monitoring is performed by measuring the dose-rate in milliroentgens per week (mr/wk) rather than the concentration in air. The environmental maximum permissible dose recommended by NCRP is 0.5 r/yr (10 mr/wk) above natural background, averaged over a one-year period.

Table 2 presents the average external gamma dose rates measured at the four stations shown in figure 2.

TABLE 2.—EXTERNAL GAMMA LEVELS AT BNL SITE BOUNDARY

[Average dose rates in mr/wk]

Period–1962	North gate	Southwest perimeter	Southeast perimeter	Northeast perimeter
Gamma dose from laboratory operations [1]				
January	0.21	0.42	0.51	1.74
February	0.63	0.21	0.77	1.47
March	0.64	0.96	0.86	1.62
April	0.32	0.12	0.84	2.57
May	0.80	0.65	0.24	3.72
June	0.67	0.40	0.26	3.46
Average	0.59	0.48	0.54	2.44
Average dose rate from undisturbed background	3.33	2.89	3.54	3.22

---

[1] Gamma dose from laboratory operation is due almost entirely to argon–41 from reactor cooling air.

Table 3.—GROSS BETA ACTIVITY IN BNL LIQUID WASTE EFFLUENT

Period–1962	Average effluent flow rate (million gallons/day)	Average beta concentration (μμc/liter)	Total beta activity discharged (mc)
January	1.10	100	12.8
February	1.11	120	15.8
March	1.78	80	15.8
April	1.49	60	10.2
May	1.18	80	9.9
June	0.84	150	14.3
Whole period	1.34	90	78.8

Water Monitoring

The BNL liquid waste effluent is monitored for gross beta concentrations at the site boundary. Table 3 presents the average concentration together with the total activity released as determined by using known effluent flow rates.

Previous coverage in *Radiological Health Data:*

Period	Issue
1959 and first quarter 1960	*December 1960*
Second quarter 1960	*February 1961*
Third and fourth quarters 1960	*June 1961*
First and second quarters 1961	*January 1962*
Third and fourth quarters 1961	*June 1962*

ROCKY FLATS PLANT
January–June 1962

Dow Chemical Company, Denver, Colorado

The Rocky Flats Plant (RFP) is engaged in plutonium fuel element fabrication under contract to the Atomic Energy Commission. To assure properly controlled release of radioactive materials to the environment, water, air, and vegetation are sampled periodically and analyzed for gross alpha activity. The most active material involved in the process is plutonium.

Because the plant is located on gravel washed out of the highly mineralized Front Range of the Rocky Mountains, heterogeneous low-level deposits of uranium, thorium, and radium exist in the soil of the area and are measurable in most samples of air, water, and vegetation as well.

Air Monitoring

During the first half of 1962, continuous 24-hour air samples were collected at Coal Creek Canyon, Marshall, Boulder, Lafayette, Broomfield, Wagner School, Golden, Denver, and Westminster. The results are tabulated in table 4. The alpha activity is believed to consist entirely of that of airborne uranium minerals.

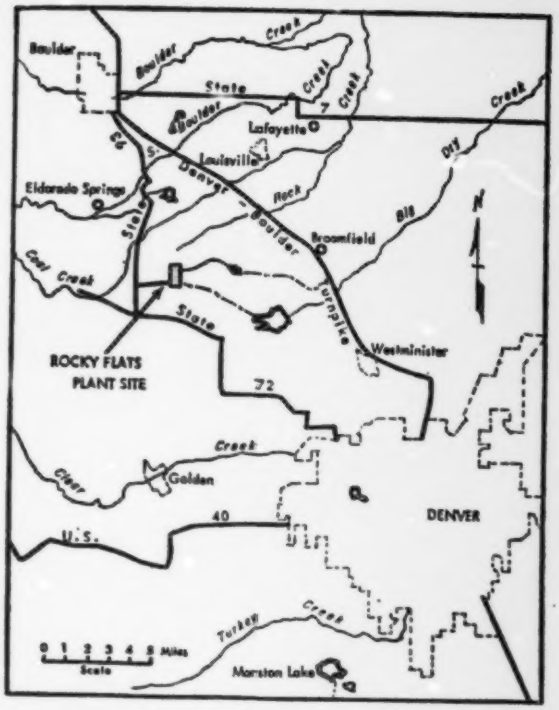
Boulder
Boulder
Creek
State
Creek
Creek
7
Boulder
Lafayette
Creek
Louisville
Dry
Eldorado Springs
Denver
Rock
Boulder
Broomfield
Big
State
N
Coal
Creek
State
Turnpike
Westminister
ROCKY FLATS
PLANT SITE
72
Creek
Clear
Golden
40
U.S.
DENVER
Turkey
Creek
0 1 2 3 4 5 Miles
Scale
Marston Lake

Figure 3.—LOCATION OF THE ROCKY FLATS PLANT ENVIRONMENT, DENVER, COLORADO

Table 4.—LONG-LIVED ALPHA ACTIVITY IN PARTICULATES IN AIR, RFP

Month (1962)	Average alpha concentration (μμc/m³)
January	<0.003
February	<0.002
March	<0.005
April	<0.003
May	<0.005
June	<0.005

Water Monitoring

Water samples were collected routinely from four reservoirs at distances ranging from 3 to 8 miles from RFP. The average alpha concentrations in the four reservoirs during the first half of 1962 varied from < 0.7 to 5.8 μμc/liter.

Non-routine raw surface water samples were collected from a number of outlying streams and lakes during fall and spring vegetation collections. Samples analyzed during the first half of 1962 included 20 fall 1961 samples and 9 spring 1962 samples whose average concentrations of unidentified alpha activity were < 1.0 and < 0.6 μμc/liter respectively.

Vegetation Samples

A total of 94 vegetation samples collected during 1961 were analyzed for gross alpha activity during the first half of 1962. The average concentration for 65 samples collected less than 3 miles from the plant was 101 μμc/kg dry weight. The 29 samples collected from 3 to 18 miles from the plant had an average concentration of 117 μμc/kg.

NEVADA TEST SITE DETONATIONS SURVEILLANCE

The July 1962 issue of *Radiological Health Data* carried (on page ii) a brief advance report from the Atomic Energy Commission noting that a low yield nuclear detonation in a tunnel chamber at the Commission's Nevada Test Site on June 13 was not fully contained underground. Gases vented from the top and face of the mesa and through the tunnel portal. Supplemental information and data recently received on offsite exposures from the June 13 detonation indicate that the cloud reached an altitude of 10,500 feet above mean sea level at about six minutes after detonation. As the cloud moved northward, it was tracked both by an airborne monitor and by ground mobile monitors. Offsite monitoring was performed by U.S. Public Health Service personnel under an agreement with the U.S. Atomic Energy Commission.

The maximum dose rate reading at any populated area was at Nyala, Nevada, where the peak reading during the passage of the cloud was 100 milliroentgens per hour. Table 5 presents exposures to the general population. These values are based on film badge readings (corrected for background radiation).

Table 5.—MEASUREMENTS OF EXPOSURE DUE TO TEST OF JUNE 13, 1962

Case	Location	Azimuth (degrees)	Distance (miles)	Dose (mr)
1	Diablo	8	50	33
2	Fallini's Range	0	67	23
3	Nyala	19	75	108
4	Nyala	19	75	233
5	Nyala	19	75	203
6	Casey's Ranch	23	77	58
7	Locke's on Hwy. 6	14	95	48
8	Jim Sharp's Blue Eagle	21	97	48
9	Jim Sharp's Blue Eagle	21	97	58
10	Jim Sharp's Blue Eagle	21	97	38
11	Jim Sharp's Blue Eagle	21	97	33
12	Roy Sharp's Blue Eagle	21	100	83
13	Roy Sharp's Blue Eagle	21	100	73
14	Roy Sharp's Blue Eagle	21	100	38
15	Manzoni Ranch	21	114	58
16	Manzoni Ranch	21	114	58
17	Manzoni Ranch	21	114	73
18	Manzoni Ranch	21	114	93
19	4 miles N. of Currant	21	115	83
20	Currant Maintenance Station	22	119	58
21	Currant Maintenance Station	22	119	38

REPORTED NUCLEAR DETONATIONS, DECEMBER 1962

Nuclear detonations reported by the Atomic Energy Commission for December 1962 are listed in table 1. Attention is called to the table footnotes which apply to previously published summaries and define the relative yield ranges of the tests. A departure from the numbering system was necessary in December because AEC did not announce a specific number of tests conducted by the U.S.S.R. between December 23 and December 25. Since AEC has indicated that at least one test was conducted on each of these dates, numbers 69–71 were arbitrarily assigned by *Radiological Health Data* for convenience in referring to the U.S.S.R. detonations reported for December.

Readers reviewing previous issues of *RHD* for nuclear detonations should note the corrections, published in the October and November 1962 issues, to the numerical listings of detonations.

TABLE 1.—SUMMARY OF NUCLEAR DETONATIONS REPORTED DURING DECEMBER 1962

Test number	Location	Date (1962)	Yield range[1]	Type of test
		REPORTED U.S.S.R. DETONATIONS[2]		
65	Novaya Zemlya	December 18	Intermediate	Atmospheric
66	Novaya Zemlya	18	Intermediate	Atmospheric
67	Novaya Zemlya	20	Low	Atmospheric
68	Novaya Zemlya	22	Intermediate	Atmospheric
[3] 69	Novaya Zemlya	23	Low[3]	Atmospheric
[3] 70	Novaya Zemlya	24	20 megatons	Atmospheric
[3] 71	Novaya Zemlya	25	"A few megatons"[3]	Atmospheric
		REPORTED U.S. DETONATIONS		
[4] —	Nevada Test Site	December 7	Low	Underground
96	Nevada Test Site	12	Low	Underground
97	Nevada Test Site	12	Low	Underground

[1] Low yield range has been announced as less than 20 kilotons yield; intermediate yield is in the range of 20 kilotons up to 1 megaton; and low megaton yield is in the range from 1 to several megatons.

[2] Only specifically announced tests, beginning in the fall of 1961, are included. The Atomic Energy Commission has advised that approximately 50 tests were conducted by the U.S.S.R. from September 1 through November 4, 1961, but only 31 specific Soviet tests were announced during that period. The Commission has also reported that the U.S.S.R. conducted more tests than specifically announced in the August-December 1962 period. Among the "Reported U.S. Detonations," tabulated since the fall of 1961, are two Plowshare Program tests designed to develop peaceful uses for nuclear explosives.

[3] Unspecified number of tests (at least one per day) conducted during December 23–25, the largest of which was 20 megatons detonated on December 24; the magnitudes of the other tests varied from the low yield range up to a few megatons.

[4] British nuclear device test conducted under the "Agreement for Cooperation on the Uses of Atomic Energy for Mutual Defense Purposes." One previous test conducted under this agreement on March 1, 1962 was reported in the September 1962 *RHD*. These two tests are not included among the numbered U.S. tests.

RADIOLOGICAL HEALTH DATA

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service • Division of Radiological Health

SECTION I.—AIR AND FALLOUT

Fission Product Beta Activity in Airborne Particulates and Precipitation

Surveillance of gross beta activity in air and precipitation permits quick and sensitive detection of fission product activity fluctuation in the environment. Although this information alone does not allow evaluation of biological effects due to fallout, it forms the basis of alerting systems and can be used as a rough index to determine when and where more extensive monitoring of radioactivity in food, milk, and water may be indicated.

October 1962 gross beta concentrations are presented in the following reports from the Canadian Radioactive Fallout Study Program, Radiation Surveillance Network, and 80th Meridian (West) Sampling Program. Because of differences in equipment and techniques the results of one network are not directly comparable with those of another. A study conducted by Lockhart and Patterson of the U.S. Naval Research Laboratory has determined intercalibration factors for comparing the results of the three networks (*1*, *2*). Relative activity values determined for the three networks are: Canadian Air Monitoring Network, 1.00; Radiation Surveillance Network, 0.65; and NRL 80th Meridian Network, 1.12 (*2*). These factors are subject to the uncertainty of air volume measurements and may not hold for very young fission products.

Presented below for the first time in *Radiological Health Data* are the Mexican Radioactive Fallout Program air monitoring results. The data cover the 12-month period from October 1961 to September 1962.

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(*1*) Lockhart, L. B., Jr., and R. L. Patterson, Jr.: *Intercalibration of Some Systems Employed in Monitoring Fission Products in the Atmosphere, NRL Report 5850*, (November 13, 1962).

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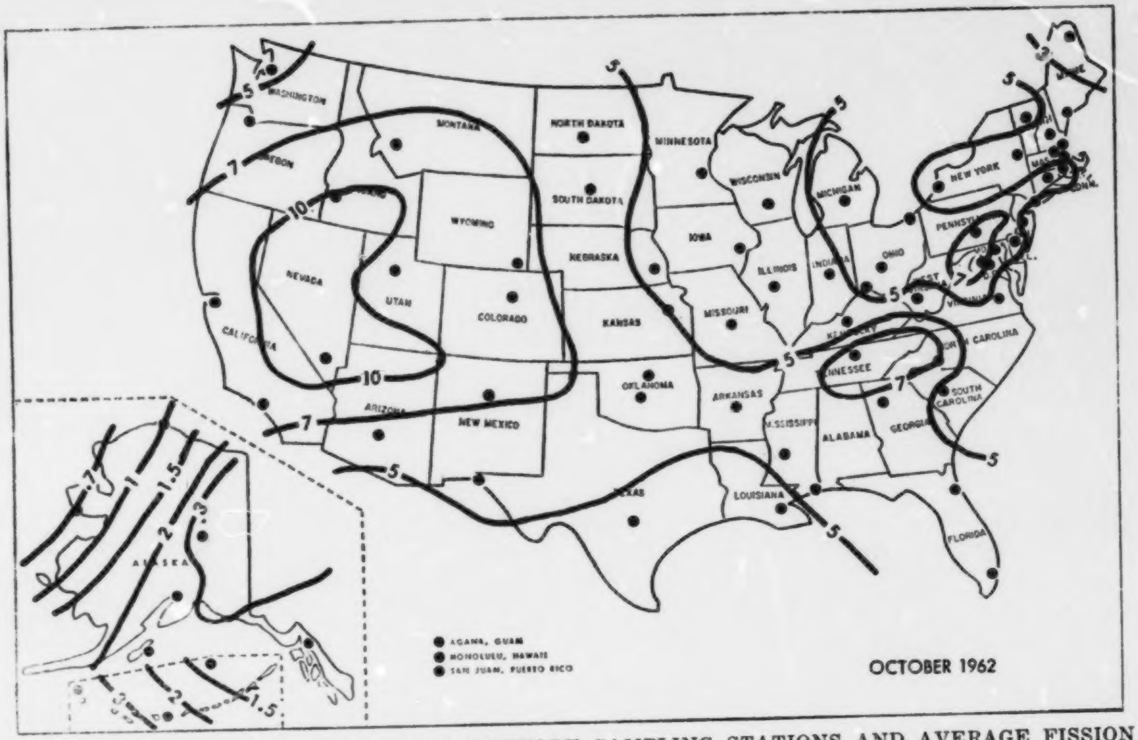
RADIATION SURVEILLANCE NETWORK
October 1962

Division of Radiological Health, Public Health Service

During October 1962, 72 sampling stations, distributed among the fifty States, Guam, and Puerto Rico, comprised the Radiation Surveillance Network (see figure 1). RSN sampling stations are manned predominantly by State Health Department personnel.

Air

Daily 24-hour air samples are collected by a high volume air sampler with a 4-inch diameter carbon-loaded cellulose dust filter. Field measurements with a portable survey meter enable the station operator to estimate the amount of beta activity in airborne particulates at the station 5 hours after collection by com-


WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
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AGANA, GUAM
HONOLULU, HAWAII
SAN JUAN, PUERTO RICO
OCTOBER 1962

FIGURE 1.—RADIATION SURVEILLANCE NETWORK SAMPLING STATIONS AND AVERAGE FISSION PRODUCT BETA CONCENTRATIONS IN AIR ($\mu\mu c/m^3$), OCTOBER 1962

parison with a known Sr^{90}-Y^{90} source. This 5-hour delay eliminates interference from naturally-occurring radon daughters. Each operator then reports his field estimate by telephone to the Radiation Surveillance Center, Division of Radiological Health, Washington, D.C., to provide a daily national report.

The filters are then forwarded to the Radiation Surveillance Network laboratory in Rockville, Maryland, for a more refined measurement using a thin-window gas-flow proportional counter. Each filter is counted at least 3 days after the end of the sampling period and re-counted 7 days later. The initial 3-day aging of the sample eliminates interference from naturally-occurring radon and thoron daughters. The two counts, separated by a 7-day interval, make possible the estimation of the age of fission products and extrapolation of the activity to the time of collection. The extrapolation is performed by using the Way-Wigner formula ($AT^{1.2} = \text{constant}$).*

Although gross beta concentration is usually presented without reference to age, it is apparent that fission product activity is more adequately described when the age parameter is also given. Studies on determining a meaningful monthly average age of fission products are now in progress.

The average fission-product beta concentrations in surface air during October 1962, as determined by laboratory analysis and extrapolated to the time of collection, are tabulated in table 1 and presented by means of concentration contours in figure 1.

Precipitation

Continuous sampling for total precipitation is conducted at most stations on a daily basis using funnels having collection areas of 0.4 m². A 500-ml aliquot of the collected precipitation is evaporated to dryness, and the residue is forwarded to the laboratory to be counted by the same method used for analyzing the air samples. If the collected sample is between 200 and 500 ml, the entire sample is evaporated;

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* In this expression, A is the activity and T is the time after fission product formation.

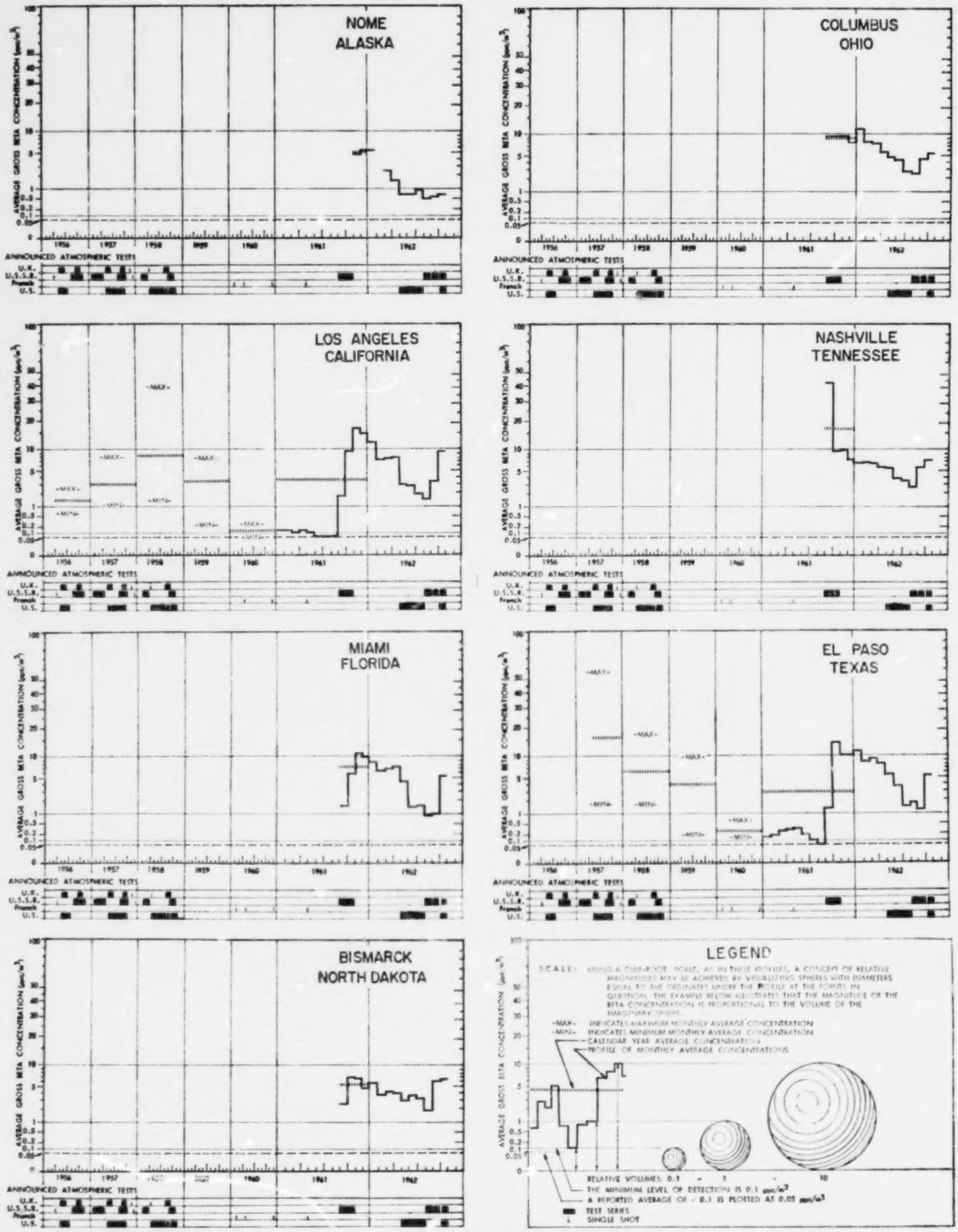

FIGURE 2.—MONTHLY AND YEARLY PROFILES OF BETA ACTIVITY IN AIR, RADIATION SURVEILLANCE NETWORK, 1956–OCTOBER 1962

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TABLE 1.—GROSS BETA ACTIVITY OF PARTICULATES IN AIR, RSN, OCTOBER 1962

[Concentrations in μμc/m³]

Station location		Number Samples	Maximum	Minimum	[a] Weighted Average
Alaska:	Adak	31	8.3	<0.10	2.2
	Anchorage	30	6.0	0.65	2.5
	Attu	31	24	<0.10	4.8
	Fairbanks	10	12	0.11	3.3
	Juneau	20	6.5	0.27	2.2
	Kodiak	31	7.2	0.71	2.6
	Nome	12	1.6	<0.10	0.70
	Point Barrow Isl	30	2.6	<0.10	1.0
	St. Paul Island	30	4.6	<0.10	1.4
Ariz:	Phoenix	31	47	3.0	12
Ark:	Little Rock	29	17	0.86	5.4
Calif:	Berkeley	31	22	0.80	6.8
	Los Angeles	21	32	2.3	9.7
Colo:	Denver	29	21	1.4	7.6
Conn:	Hartford	30	20	0.92	5.1
Del:	Dover	22	27	0.63	5.7
D.C:	Washington	31	21	0.37	4.7
Fla:	Jacksonville	31	24	0.31	6.0
	Miami	31	15	0.22	5.2
Ga:	Atlanta	31	29	0.57	5.4
Guam:	Agana	—	—	—	—
Hawaii:	Honolulu	31	16	0.36	3.1
Idaho:	Boise	31	36	0.78	10
Ill:	Springfield	31	12	0.87	4.5
Ind:	Indianapolis	30	17	1.9	4.9
Iowa:	Iowa City	30	12	0.38	3.2
Kans:	Topeka	29	18	0.26	5.0
Ky:	Frankfort	28	20	1.5	4.3
La:	New Orleans	31	13	0.13	4.5
Maine:	Augusta	31	7.7	0.96	3.2
	Presque Isle	31	6.5	0.18	2.3
Md:	Baltimore	23	23	0.81	5.4
	Rockville	20	12	2.0	7.4
Mass:	Lawrence	30	9.3	0.21	3.9
	Winchester	30	11	0.78	4.6
Mich:	Lansing	31	16	0.90	5.2
Minn:	Minneapolis	30	20	0.68	4.0
Miss:	Jackson	29	13	0.13	5.4
	Pascagoula	18	15	0.26	6.1
Mo:	Jefferson City	30	16	0.90	4.7
Mont:	Helena	31	25	1.7	9.1
Nebr:	Lincoln	16	4.3	0.30	1.8
Nev:	Las Vegas	28	72	3.3	14
N.H:	Concord	21	14	1.6	4.6
N.J:	Trenton	31	19	0.14	4.7
N. Mex:	Sante Fe	29	22	1.3	8.2
N.Y:	Albany	30	15	0.11	4.5
	Buffalo	28	9.9	0.12	4.6
	New York	15	22	0.17	4.8
N.C:	Gastonia	30	19	0.36	7.0
N. Dak:	Bismarck	31	25	0.42	6.7
Ohio:	Cincinnati	21	18	2.0	6.8
	Columbus	31	27	1.9	5.4
	Painesville	29	18	1.4	5.2
Okla:	Oklahoma City	31	18	0.24	5.2
	Ponca City	28	9.4	<0.10	2.5
Ore:	Portland	30	39	2.3	7.2
Pa:	Harrisburg	25	48	1.3	8.4
P.R:	San Juan	30	3.0	0.11	0.72
R.I:	Providence	31	12	0.13	5.0
S.C:	Columbia	31	12	0.18	4.4
S. Dak:	Pierre	31	15	0.54	5.8
Tenn:	Nashville	29	27	1.0	7.3
Tex:	Austin	30	17	0.12	4.7
	El Paso	30	15	0.45	5.2
Utah:	Salt Lake City	31	22	1.7	8.1
Vt:	Barre	31	17	0.54	5.5
Va:	Richmond	31	22	0.65	4.6
Wash:	Seattle	30	15	0.97	4.3
W. Va:	Charleston	31	21	1.5	4.7
Wis:	Madison	31	17	0.67	4.3
Wyo:	Cheyenne	31	29	1.5	8.2
Network average					5.2

[a] Weighted average obtained by summing the products of individual sampling times and the corresponding activities, and dividing by the summation of the individual sampling times.

TABLE 2.—GROSS BETA ACTIVITY IN PRECIPITATION, RSN, OCTOBER 1962

Station location		Average concentration (μμc/liter)	Total deposition (mμc/m²)
Alaska	Adak	*	*
	Anchorage	1,300	21
	Attu	*	*
	Fairbanks	*	*
	Juneau	1,800	360
	Kodiak	*	*
	Nome	*	*
	Pt. Barrow Island	*	*
	St. Paul Island	*	*
Ariz.	Phoenix	*	*
Ark.	Little Rock	480	54
Calif.	Berkeley	400	120
	Los Angeles	27,000	16
Colo.	Denver	*	*
Conn.	Hartford	3,600	300
Del.	Dover	*	*
D.C.	Washington	920	38
Fla.	Jacksonville	640	20
	Miami	830	52
Ga.	Atlanta	900	7.8
Guam	Agana	*	*
Hawaii	Honolulu	*	*
Idaho	Boise	1,400	44
Ill.	Springfield	480	64
Ind.	Indianapolis	640	70
Iowa	Iowa City	1,100	98
Kans.	Topeka	2,700	9.5
Ky.	Frankfort	870	37
La.	New Orleans	1,900	69
Maine	Augusta	1,700	320
	Presque Isle	2,000	51
Md.	Baltimore	400	4
	Rockville	2,700	24
Mass.	Lawrence	7,000	200
	Winchester	1,200	70
Mich.	Lansing	4,700	210
Minn.	Minneapolis	1,100	49
Miss.	Jackson	450	17
	Pascagoula	400	10
Mo.	Jefferson City	1,800	150
Mont.	Helena	4,000	71
Nebr.	Lincoln	1,300	45
Nev.	Las Vegas	5,000	3
N.H.	Concord	*	*
N.J.	Trenton	1,100	8.9
N. Mex.	Santa Fe	760	11
N.Y.	Albany	1,200	48
	Buffalo	1,800	68
	New York	*	*
N.C.	Gastonia	440	18
N. Dak.	Bismarck	2,000	18
Ohio	Cincinnati	*	*
	Columbus	1,100	4.8
	Painesville	2,400	170
Okla.	Oklahoma City	600	15
	Ponca City	530	27
Ore.	Portland	2,200	120
Pa.	Harrisburg	600	50
P.R.	San Juan	400	110
R.I.	Providence	1,900	150
S.C.	Columbia	400	6.5
S. Dak.	Pierre	810	4.9
Tenn.	Nashville	590	29
Tex.	Austin	700	50
	El Paso	510	7.1
Utah	Salt Lake City	2,400	51
Vt.	Barre	860	100
Va.	Richmond	870	1.8
Wash.	Seattle	790	180
W. Va.	Charleston	1,300	42
Wis.	Madison	1,100	27
Wyo.	Cheyenne	920	10

* Indicates no evaporated sample received.

if less than 200 ml (equivalent to 0.5 mm or 0.02 inches of rainfall), the volume of precipitation is reported, but no analysis is made. October 1962 averages of gross beta activity in precipitation, expressed in micromicrocuries per liter (μμc/liter) and millimicrocuries per square meter (mμc/m²), are shown in table 2.

Profiles

The profiles of the monthly average fission product beta activity in airborne particulates for 7 stations, updated through October 1962, are shown in figure 2.

CANADIAN RADIOACTIVE FALLOUT STUDY PROGRAM

October 1962

Department of National Health and Welfare, Ottawa, Canada

As part of its Radioactive Fallout Study Program (RFSP), the Radiation Protection Division, Department of National Health and Welfare, Dominion of Canada, conducts air and precipitation sampling programs. The 24 air and precipitation stations are located at airports (see figure 3), and the equipment is operated by meteorologists of the Meteorological Services Branch of the Department of Transport.

More detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in the Department's annual reports for 1959 and 1960 (*1,2*).

Air

About 650 cubic meters of air are drawn through a high-efficiency 4-inch-diameter filter during a 24-hour period. Filters are sent daily to the Radiation Protection Division Laboratory in Ottawa. A 2-inch-diameter disk is removed from each filter and counted with a thin end-window Geiger flow counter system, calibrated with a Sr^{90}-Y^{90} standard. Four successive measurements are made on each filter to allow for the presence of natural activities and for the decay of short-lived fission products. The result is extrapolated to the end of the sampling period. Air data for October 1962 are presented in table 3.

Precipitation

The amount of radioactive fallout being deposited on the ground is determined from measurements on material collected in special polythene-lined rainfall pots. After transfer of the water to the sampling container, the polythene liner is removed, packed with the sample, and sent to the laboratory. October 1962 precipitation data, including some radiochemical analyses, are presented in table 4. (see p. 68).

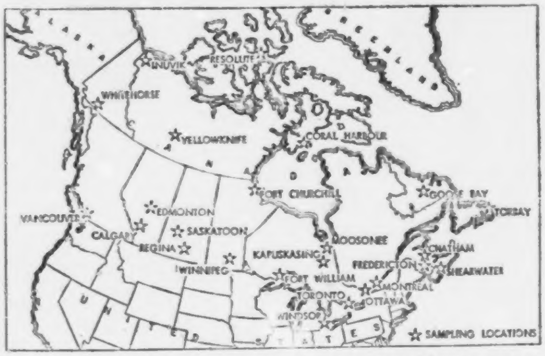

FIGURE 3.—CANADIAN AIR AND PRECIPITATION SAMPLING STATIONS

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(*2*) Bird, P. M., A. H. Booth, and P. G. Mar: *Annual Report for 1960 on the Radioactive Fallout Study Program, CNHW (RP-3)*, (December 1961).

TABLE 3.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, RFSP, OCTOBER 1962

[Average concentrations in μμc/m³]

Station	Number of samples	Maximum	Minimum	Average
Calgary	31	49.3	2.5	18.0
Chatham	31	12.5	0.1	4.8
Coral Harbor	31	20.0	0.1	3.2
Edmonton	31	76.5	0.5	13.2
Ft. Churchill	31	15.5	0.5	3.1
Ft. William	31	20.6	1.7	7.3
Fredericton	31	13.6	1.2	5.0
Goose Bay	30	12.9	0.0	4.8
Inuvik	31	9.6	0.0	2.7
Kapuskasing	29	13.5	1.4	5.8
Montreal	30	36.0	1.5	8.1
Moosonee	28	11.7	1.7	5.6
Ottawa	30	23.0	1.0	8.0
Regina	31	112.0	1.7	14.8
Resolute	8	1.6	0.6	1.2
Saskatoon	31	70.0	1.8	15.1
Shearwater	31	47.0	0.7	6.6
Torbay	30	16.6	0.0	4.6
Toronto	31	20.0	0.1	8.4
Vancouver	31	25.8	1.5	8.8
Whitehorse	31	13.3	0.8	4.4
Windsor	29	27.5	2.8	10.3
Winnipeg	29	52.0	1.2	12.9
Yellowknife	31	15.5	0.2	4.4
Network Average				7.5

TABLE 4.—FISSION PRODUCT GROSS BETA ACTIVITY IN PRECIPITATION, RFSP, OCTOBER 1962

Station	Total beta activity		Deposition of specific radionuclides for selected samples[1,2] (mμc/m²)				
	μμc/liter	mμc/m²	Sr^{89}	Sr^{90}	Zr^{95}	Cs^{137}	Ba^{140}
Calgary	9,804	94.6	6.31	0.30	14.4	0.45	17.0
Chatham	2,234	286.0					
Coral Harbour	1,894	46.2					
Edmonton	6,208	69.4					
Fredericton	3,025	245.0					
Ft. Churchill	1,218	46.0					
Ft. William	6,980	88.6					
Goose Bay	838	63.1					
Inuvik	3,178	63.8					
Kapuskasing	698	26.7					
Montreal	1,984	231.2	18.8	0.88	33.5	1.35	33.4
Moosonee	1,968	88.0					
Ottawa	2,686	308.3					
Regina	3,443	125.0					
Resolute	9,223	72.6					
Saskatoon	9,701	69.0					
Shearwater	532	77.2	18.3	0.69	11.0	1.18	24.1
Torbay	664	108.4					
Toronto	1,631	113.0					
Vancouver	1,455	173.6	15.8	0.71	21.6	1.30	21.6
Whitehorse	1,874	49.0					
Windsor	2,099	87.4					
Winnipeg	4,677	86.7	5.65	0.30	15.8	0.53	10.3
Yellowknife	2,025	31.9					
Average	3,335	110.4					

[1] All values corrected for decay back to end of collection month.

[2] Values for strontium-90, cesium-137, and Zirconium-95 do not include the activities of their daughter isotopes, yttrium-90, barium-137, and niobium-95.

MEXICAN RADIOACTIVE FALLOUT PROGRAM

October 1961–September 1962

National Commission of Nuclear Energy, Mexico

The Radiation Surveillance Network of Mexico was established by the "Comisión Nacional de Energía Nuclear" (CNEN), through its Radiological Protection Program (RPP) in 1961, to provide a means for determining increased levels of radioactivity in air and precipitation due to fallout from nuclear tests.

Prior to the establishment of the network, two pilot sampling stations were set up in Mexico City and San Luis Potosí to aid in the selection of equipment and sampling sites. Since April 1962 the network has been expanded to eleven stations, nine of which were in operation by the end of September 1962 (see figure 4 and table 5).

Seven of the nine sampling stations are located at airports and operated by airline personnel. The remaining two stations are located at Mexico City and Veracruz and are operated, respectively, by staff members of RPP and the "Centro de Previsión del Golfo de México."

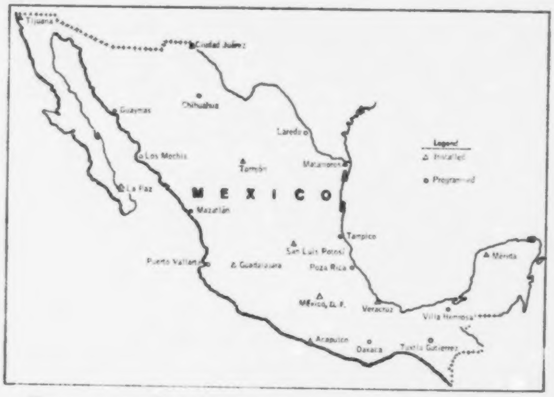

Tijuana
Ciudad Juárez
Chihuahua
Guaymas
Laredo
Los Mochis
Torreón
Matamoros
La Paz
MEXICO
Mazatlán
Tampico
San Luis Potosí
Puerto Vallarta
Guadalajara
Poza Rica
México, D. F.
Veracruz
Mérida
Villa Hermosa
Acapulco
Oaxaca
Tuxtla Gutiérrez
Legend
△ Installed
○ Programmed

FIGURE 4.—FALLOUT NETWORK SAMPLING STATIONS IN MEXICO

TABLE 5.—GEOGRAPHICAL SITUATION OF SAMPLING STATIONS

Station	Latitude	Elevation (meters above sea level)
México, D. F.	19°20′N	2,268
San Luis Potosí	22°09′N	1,877
Torreón	25°32′N	1,140
Matamoros	25°52′N	12
Veracruz	19°12′N	14
Mérida	20°59′N	9
Acapulco	16°50′N	2
Guadalajara	20°40′N	1,517
La Paz	24°09′N	10
Tijuana	32°30′N	—
Ciudad Juárez	28°38′N	1,660

Sampling

The sampling procedure involves drawing air 24 hours a day, 3 or 4 days a week, at the rate of approximately 1,200 cubic meters per day through a 6″ x 8″ high-efficiency glass fiber filter, using high volume samplers. After each 24-hour period the filter is removed and airmailed to the "Laboratorio de Desechos Radiactivos," CNEN, in Mexico City for assay of gross beta activity. After collection, a minimum of 3 or 4 days is allowed for decay of radon and thoron daughters. Data are not extrapolated to time of collection.

The maximum, minimum, and average fission product beta concentrations in surface air from October 1961 to September 1962 are presented in table 6.

TABLE 6.—GROSS BETA ACTIVITY OF PARTICLES IN AIR, OCTOBER 1961—SEPTEMBER 1962

[Concentrations in $\mu\mu c/m^3$]

Month	Station	Number of samples	Maximum	Minimum	Average
1961 October	México	14	5.88	0.10	1.52
	San Luis Potosí	7	10.71	0.51	3.8[illegible]
November	México	16	3.83	0.10	1.42
	San Luis Potosí	6	13.42	0.46	4.02
December	México	15	11.53	1.43	5.84
	San Luis Potosí	6	3.83	1.19	2.58
1962 January	México	13	8.23	2.58	6.04
	San Luis Potosí	11	29.64	0.61	9.59
February	México	9	7.51	2.55	4.41
	San Luis Potosí	10	17.10	2.93	7.43
March	México	10	3.43	0.64	1.94
	San Luis Potosí	9	13.64	0.92	7.82
April	México	5	3.47	0.43	2.00
	San Luis Potosí	9	13.64	0.92	7.82
	Torreón	12	13.40	4.47	8.63
	Veracruz	5	15.08	4.36	8.54
	La Paz	3	7.41	1.95	4.52
May	México	6	9.81	4.90	7.07
	San Luis Potosí	12	12.26	4.63	7.16
	Torreón	12	11.25	3.51	6.45
	Veracruz	3	9.88	4.40	7.62
	La Paz	9	5.95	2.14	3.62
	Acapulco	4	6.37	2.41	4.13
	Tijuana	12	8.06	0.72	4.17
June	San Luis Potosí	11	6.11	0.39	2.58
	Torreón	10	4.56	0.51	2.62
	Veracruz	10	2.25	0.84	1.15
	La Paz	12	5.61	1.31	3.32
	Acapulco	4	2.24	0.75	1.40
	Ciudad Juárez	4	17.66	2.39	8.14
July	México	10	1.60	0.90	2.42
	San Luis Potosí	7	4.90	0.50	1.91
	Torreón	7	2.30	0.50	1.59
	Veracruz	6	1.60	0.50	0.95
	La Paz	7	63.50	1.10	11.26
	Acapulco	4	1.00	0.20	0.62
	Ciudad Juárez	9	4.90	1.00	1.97
August	México	20	10.10	0.20	2.53
	San Luis Potosí	—	—	—	—
	Torreón	10	30.40	0.30	6.63
	Veracruz	9	1.00	0.20	0.70
	La Paz	4	2.60	0.80	1.52
	Acapulco	—	—	—	—
	Ciudad Juárez	13	18.40	1.10	5.14
	Tijuana	5	3.00	0.90	1.76
	Guadalajara	16	1.50	0.20	0.72
September	México	9	0.60	0.20	0.24
	San Luis Potosí	10	0.80	0.10	0.43
	Torreón	5	1.50	0.40	0.78
	Veracruz	7	0.80	0.20	0.51
	La Paz	4	14.70	0.40	4.52
	Acapulco	3	0.30	0.20	0.25
	Ciudad Juárez	7	6.50	0.70	3.24
	Tijuana	5	8.10	3.80	6.20
	Guadalajara	8	1.00	0.10	0.63

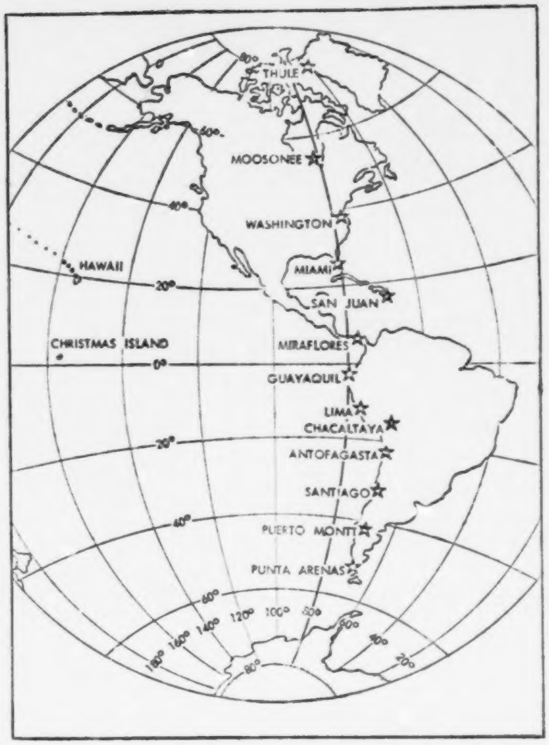
*Dash indicates no data received.

THE 80th MERIDIAN (WEST) SAMPLING PROGRAM
October 1962

U.S. Naval Research Laboratory

Radioactivity measurements of surface air samples collected at various sites (see figure 5) near the 80th Meridian (West) have been made since 1956 by the U.S. Naval Research Laboratory (NRL),* with the cooperation of interested agencies of the United States, Canada, Ecuador, Peru, Bolivia, and Chile, which collect the samples and forward them to NRL for analysis. Partial financial support of this program is provided by the Division of Biology and Medicine, U.S. Atomic Energy Commission.

The sampling procedure involves drawing air continuously for a 7-day period at a rate of approximately 1200 cubic meters per day through an 8-inch diameter, high-efficiency filter, using a positive-displacement blower. After the 7-day period, the filter is removed and forwarded to NRL for assay of gross beta activity. A minimum of 2 weeks after collection is allowed for decay of short-lived radionuclides. Data in table 7 are not extrapolated to time of collection.



THULE
MOOSONEE
WASHINGTON
HAWAII
MIAMI
SAN JUAN
CHRISTMAS ISLAND
MIRAFLORES
GUAYAQUIL
LIMA
CHACALTAYA
ANTOFAGASTA
SANTIAGO
PUERTO MONTT
PUNTA ARENAS
60°
40°
20°
0°
20°
40°
60°
80°
180°
160°
140°
120°
100°
80°
60°
40°
20°

FIGURE 5.—ATMOSPHERIC RADIOACTIVITY SAMPLING STATIONS NEAR THE 80TH MERIDIAN (WEST)

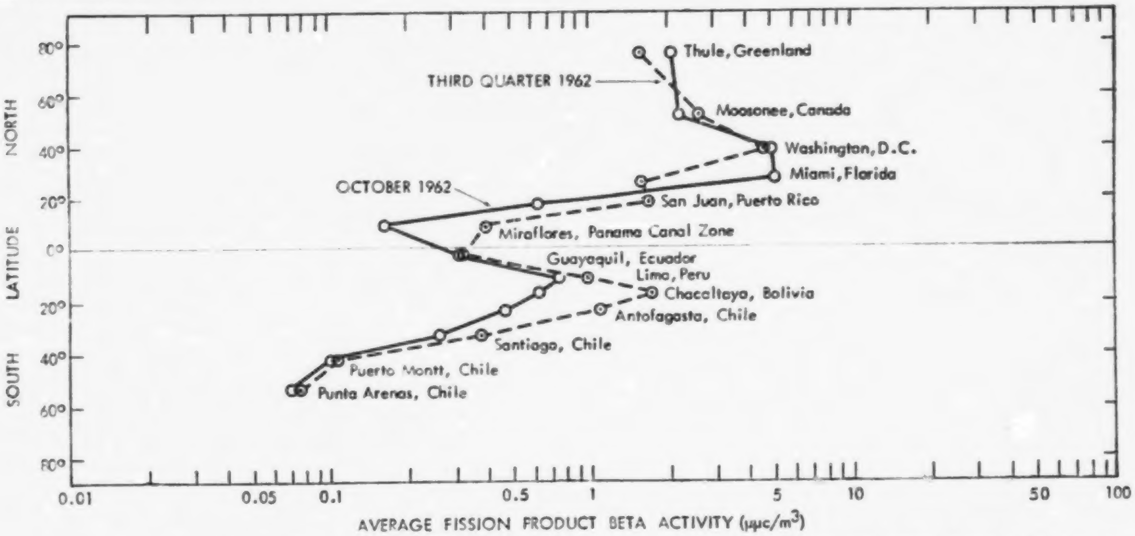


FIGURE 6.—PROFILE OF BETA ACTIVITY, AVERAGE MEASUREMENT OF SURFACE AIR AT STATIONS NEAR THE 80TH MERIDIAN (WEST) OCTOBER 1962

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* *Editor's note: Effective January 1, 1963, administration of the 80th Meridian (West) Sampling Program was turned over to the Health and Safety Laboratory, Division of Biology and Medicine, AEC, by the U.S. Naval Research Laboratory.*

TABLE 7.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, 80TH MERIDIAN (WEST), OCTOBER 1962[a]

Sampling period October	Punta Arenas, Chile	Puerto Montt, Chile	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador	Miraflores, Panama Canal Zone	San Juan, P. R.	Mauna Loa, Hawaii[b]	Miami, Florida	Washington, D. C.	Moosonee, Ontario, Canada	Thule, Greenland
1	0.139	0.145	0.398	0.868	0.630	0.828	1.22	—	0.077	0.868	0.860	2.19	1.87	2.06
2 3 4 5 6 7 8	0.054	0.099	0.280	0.353	0.949	0.792	0.054	0.077	0.500	[c]—	1.48	3.71	3.73	2.06
9 10 11 12 13 14 15	—	0.141	0.282	0.630	0.706	0.742	0.108	0.271	0.500	1.90	4.44	3.98	3.38	2.43
16 17 18 19 20 21 22	0.084	0.076	0.258	0.554	0.446	0.464	0.576	0.138	0.486	1.19	6.48	7.02	1.25	1.56
23 24 25 26 27 28 29	0.065	0.098	—	0.310	0.459	0.999	0.175	0.182	0.842	2.74	8.37	5.90	1.15	2.45
30 31	0.069	—	0.290	0.711	0.662	—	0.102	0.144	1.42	2.07	6.62	3.31	1.86	2.12
Weighted average	0.071	0.105	0.280	0.390	0.639	0.752	0.325	0.166	0.644	1.91	5.13	4.95	2.33	2.12

[a] The average concentration determined from a given sample is placed at the center of the rectangle which indicates the length and dates of the sampling period (normally 7 days). Station averages for the month were determined by weighting the sample average according to the number of days in the sampling period or that portion of the sampling period occurring in October 1962.

[b] Mauna Loa data have been included for comparison with Chacaltaya, Bolivia. Both are high elevation stations (3400 and 5200 meters) and about equally distant north and south of the equator.

[c] Dash indicates samples were not received.

Airborne Fission Products Along the 80th Meridian (West) During 1961

L. B. Lockhart, Jr., R. L. Patterson, Jr.
A. W. Saunders, Jr., and R. W. Black[1]

The cooperative 80th Meridian (West) Air Sampling Program, conducted since its inception in 1956 under the direction of the U.S. Naval Research Laboratory,[2] was designed to provide a means of studying the effect of latitude on the distribution of fission products in the atmosphere, to obtain information on the mechanism and rate of mixing of fission debris in a north-south direction and particularly across the equator, and to serve as a reference line to which the various independent measurements of fission product concentrations could be related. An important and time-consuming phase of this work involved the radiochemical analysis of the collected samples whose gross beta measurements are regularly reported in this journal.

Experimental Procedure

The procedure employed at each site involved the collection of airborne particulate matter by drawing ground-level air through highly efficient cellulose-asbestos filters 8 inches in diameter at the rate of about 1200 cubic meters

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[1] Dr. Lockhart is Head of the Physical Chemistry Branch, and Mr. Patterson is Head and Messrs. Saunders and Black are staff members of the Radiochemistry Section, Physical Chemistry Branch, U.S. Naval Research Laboratory, Washington, D.C.

[2] Partial financial support of this program has been provided by the Fallout Studies Branch, Division of Biology and Medicine, U.S. Atomic Energy Commission.

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TABLE 1.—RADIOCHEMICAL ANALYSES OF BIMONTHLY COMPOSITE AIR-FILTER COLLECTIONS, 80TH MERIDIAN (WEST) SAMPLING PROGRAM, 1961

(Activity in $\mu\mu c/m^3$)[a]

Station	Sampling period		Gross β	Ce^{141}	Sr^{89}	Y^{91}	Ce^{144}	Pm^{147}	Sr^{90}	Cs^{137}	Pb^{210}
	1961	Days sampled[b]									
Thule, Greenland (elevation 259 meters)	Jan–Feb	59	0.054	[c] •	•	•	0.0067	0.0069	0.00220	0.00390	0.0102
	Mar–Apr	59	0.090	•	[d] —	—	—	—	0.00438	0.0074	0.0124
	May–Jun	63	0.072	•	•	•	0.0096	0.0100	0.00325	0.0064	0.0068
	Jul–Aug	59	0.032	•	•	•	0.0037	0.0048	0.00158	0.00277	0.00329
	Sep–Oct	63	1.38	0.303	0.114	0.160	0.048	0.0118	0.00140	0.00204	0.00359
	Nov–Dec	58	5.58	1.12	0.562	0.886	0.344	—	0.0092	0.0119	0.0092
Moosonee, Canada (elevation 10 meters)	Jan	25	0.050	•	•	•	0.00418	0.00353	0.00132	0.00209	0.0194
	Mar	32	0.10	•	•	•	0.0094	0.0087	0.00305	0.0062	0.0219
	May–Jun	56	0.080	•	•	•	0.0127	0.0134	0.0047	0.0074	0.0036
	Jul–Aug	63	0.036	•	•	•	0.0064	0.0075	0.00264	0.0050	0.0067
	Sep–Oct	59	3.65	0.788	0.261	0.395	0.099	0.0245	0.00285	0.0056	0.0070
	Nov–Dec	59	3.74	0.598	0.317	0.495	0.192	—	0.0046	0.0093	0.0159
Washington, D.C. (elevation 82 meters)	Jan–Feb	59	0.063	•	•	•	0.0067	0.0054	0.00198	0.00377	0.0245
	Mar–Apr	60	0.094	•	•	•	0.0108	0.0111	0.00332	0.0070	0.0156
	May–Jun	63	0.14	•	•	•	0.0176	0.0201	0.0060	0.0118	0.0144
	Jul–Aug	58	0.072	•	•	•	0.0070	0.0063	0.00238	0.0050	0.0098
	Sep–Oct	63	3.88	1.089	0.437	0.526	0.125	0.0321	0.00364	0.0069	0.0243
	Nov–Dec	56	4.66	0.742	0.590	0.819	0.297	—	0.0067	0.0127	0.0081
Miami, Florida (elevation 4 meters)	Jan–Feb	61	0.086	•	•	•	0.0091	0.0078	0.00248	0.00375	0.0086
	Mar–Apr	60	0.16	•	•	•	0.0195	0.0195	0.0058	0.0095	0.0128
	May–Jun	62	0.10	•	•	•	0.0141	0.0141	0.00434	0.0082	0.0102
	Jul–Aug	51	0.036	•	•	•	0.00430	0.0057	0.00159	0.00242	0.0065
	Sep–Oct	63	2.25	0.761	0.307	0.353	0.0801	0.0178	0.00304	0.00342	0.00442
	Nov–Dec	56	6.73	1.90	0.819	1.33	0.459	—	0.0124	0.0094	0.00378
Mauna Loa, Hawaii (elevation 3394 meters)	Jan–Feb	59	0.050	•	•	•	0.0055	0.0050	0.00173	0.00304	0.0068
	Mar–Apr	60	0.11	•	•	•	0.0184	0.0142	0.00444	0.0083	0.0084
	May–Jun	63	0.12	•	•	•	0.0143	0.0128	0.0050	0.0090	0.0110
	Jul–Aug	59	0.058	•	•	•	0.0075	0.0085	0.00270	0.0053	0.0084
	Sep–Oct	53	0.60	0.114	0.050	0.054	0.0158	0.0057	0.00145	0.00274	0.0050
	Nov–Dec	56	4.95	0.918	0.630	0.909	0.301	—	0.0076	0.0130	0.00260
Miraflores, Panama Canal Zone (elevation 10 meters	Jan–Feb	59	0.16	0.0090	0.0046	0.0046	0.0055	0.00429	0.00136	0.00238	0.00339
	Mar–Apr	60	0.063	[e] 1.0055	•	•	0.0050	0.0057	0.00156	0.00249	0.0060
	May–Jun	63	0.050	•	•	•	0.00389	0.00411	0.00125	0.00228	0.0086
	Jul–Aug	59	0.014	•	•	•	0.00084	0.00100	0.00031	0.00049	0.00343
	Sep–Oct	63	0.032	[e] 0.0048	[e] 0.0022	[e] 0.0036	0.00074	0.00032	0.00018	0.00042	0.00190
	Nov–Dec	55	1.23	0.217	0.115	0.190	0.057	0.0220	0.00158	0.00173	0.00140
Guayaquil, Ecuador (elevation 7 meters)	Jan–Feb	53	0.022	[f] 0.0027	[f] 0.0001	•	0.00127	0.00220	0.00038	0.00086	0.0101
	Mar–Apr	59	0.022	•	•	•	0.00106	0.00103	0.00036	0.00091	0.0121
	May–Jun	33	0.018	•	•	•	0.00112	0.00104	0.00039	0.00072	0.0081
	Jul–Aug	56	0.009	•	•	•	0.00045	0.00057	0.00021	0.00043	0.0070
	Sep–Oct	63	0.014	[f] 0.0001	•	•	0.00090	0.00121	0.00045	0.00094	0.0069
	Nov–Dec	62	0.058	0.0144	0.0104	0.0130	0.0064	0.00321	0.00108	0.00238	0.0107
Lima, Peru (elevation 30 meters)	Jan–Feb	51	0.018	•	•	•	0.00189	0.00151	0.00070	0.00129	0.00248
	Mar–Apr	60	0.014	•	•	•	0.00108	0.00089	0.00044	0.00087	0.00080
	May–Jun	63	0.027	•	•	•	0.00233	0.00202	0.00094	0.00093	0.00371
	Jul–Aug	52	0.027	•	•	•	0.00256	0.00248	0.00112	0.00170	0.00317
	Sep–Oct	61	0.032	•	•	•	0.0049	0.0054	0.00234	0.00832	0.00285
	Nov–Dec	64	0.027	[e] 0.0030	[e] 0.0027	[e] 0.0038	0.00301	0.00241	0.00112	0.00199	0.00212
Chacaltaya, Bolivia (elevation 5220 meters)	Jan–Feb	51	0.022	•	•	•	0.00131	0.00109	0.00044	0.00102	0.0084
	Mar–Apr	54	0.027	•	•	•	0.00171	0.00169	0.00068	0.00148	0.0090
	May–Jun	51	0.027	•	•	•	0.00164	0.00153	0.00068	0.00152	0.0116
	Jul–Aug	63	0.050	•	•	•	0.0051	0.0058	0.00216	0.00408	0.0171
	Sep–Oct	62	0.045	[f] 0.0019	•	[f] 0.0009	0.00343	0.00393	0.00168	0.00310	0.0132
	Nov–Dec	63	0.068	[e] 0.0072	[e] 0.0053	[e] 0.0068	0.00456	0.00293	0.00124	0.00232	0.00940
Antofagasta, Chile (elevation 519 meters)	Jan–Feb	43	0.054	•	•	•	0.0063	0.0053	0.00228	0.00344	0.0061
	Mar–Apr	60	0.036	•	•	•	0.00428	0.00440	0.00157	0.00335	0.0155
	May–Jun	60	0.036	•	•	•	0.00359	0.00356	0.00140	0.00275	0.0174
	Jul–Aug	52	0.032	•	•	•	0.0046	0.0050	0.00186	0.00333	0.00445
	Sep–Oct	63	0.036	[f] 0.0037	•	•	0.0059	0.0063	0.00254	0.00513	0.00226
	Nov–Dec	63	0.072	[e] 0.0057	[e] 0.0040	[e] 0.0059	0.0071	0.0071	0.00266	0.00481	0.00268
Santiago, Chile (elevation 520 meters)	Jan	25	0.058	•	•	•	0.0089	0.0080	0.00319	0.0065	0.0058
	Mar–Apr [g]										
	May	31	0.036	•	•	•	0.00306	0.00247	0.00125	0.00199	0.0125
	Jul–Aug [h]										
	Sep–Oct	63	0.032	•	•	[f] 0.0010	0.00437	0.0063	0.00188	0.00409	0.00366
	Nov–Dec	63	0.045	[f] 0.0004	[f] 0.0008	[f] 0.0007	0.00409	0.0055	0.00222	0.00452	0.0056
Puerto Montt, Chile (elevation 5 meters)	Jan–Feb [g]										
	Mar–Apr [h]										
	May–Jun [h]										
	Jul–Aug	54	0.018	•	•	•	0.00209	0.00216	0.00097	0.00140	0.00266
	Sep–Oct	63	0.018	•	•	•	0.00227	0.00276	0.00117	0.00132	0.00123
	Nov–Dec	63	0.018	•	[f] 0.0007	•	0.00288	0.00353	0.00157	0.00239	0.00079
Punta Arenas, Chile (elevation 3 meters)	Jan–Feb	47	0.018	•	•	•	0.00220	0.00193	0.00083	0.00167	0.00072
	Mar–Apr	60	0.014	•	•	•	0.00182	0.00191	0.00080	0.00156	0.00016
	May–Jun	44	0.014	•	•	•	0.00121	0.00106	0.00049	0.00094	0.00071
	Aug–Sep [i]	55	0.014	•	•	•	0.00130	0.00151	0.00063	0.00119	0.00079
	Oct	35	0.009	•	•	•	0.00098	0.00150	0.00070	0.00118	0.00066
	Nov–Dec	56	0.009	[f] 0.0004	[f] 0.0001	•	0.00084	0.00112	0.00050	0.00101	0.00057

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[a] Counting error <2 percent (σ) unless otherwise indicated. [b] Irregularities in numbers result from varying sampling schedules; initially 3 samples per week per station, later one 7-day collection per week. [c] • indicates activity too low for measurement. [d] — indicates no analytical results reported. [e] Counting error in range of 2–10 percent (σ). [f] Indicates counting error >10 percent (σ). [g] No samples received. [h] Insufficient samples received. [i] Error made in grouping samples for analysis.

TABLE 2.—SELECTED RADIONUCLIDE ACTIVITY RATIOS, 80TH MERIDIAN SAMPLING PROGRAM, 1961

Station	Sampling period		Ce^{141}/Ce^{144}	Ce^{144}/Pm^{147}	Ce^{144}/Sr^{90}	Cs^{137}/Sr^{90}	Pb^{210}/Sr^{90}	$\frac{Pb^{210}}{\text{Gross } \beta}$	Sr^{89}/Sr^{90}
	1961	Days sampled							
Thule, Greenland	Jan–Feb	59	0.0	0.97	3.05	1.77	4.6	0.19	0.0
	Mar–Apr	59		—	—	1.69	2.8	0.14	0.0
	May–Jun	63	0.0	0.97	2.95	1.97	2.1	0.09	0.0
	Jul–Aug	59	0.0	0.77	2.35	1.76	2.1	0.10	0.0
	Sep–Oct	63	6.35	4.05	34.0	1.45	2.6	0.0026	81.4
	Nov–Dec	58	3.26		37.3	1.29	1.0	0.0017	61.0
Moosonee, Canada	Jan	25	0.0	1.19	3.16	1.58	14.6	0.39	0.0
	Mar	32	0.0	1.08	3.07	2.02	7.2	0.21	0.0
	May–Jun	56	0.0	0.95	2.70	1.56	0.76	0.04	0.0
	Jul–Aug	63	0.0	0.85	2.42	1.88	2.5	0.18	0.0
	Sep–Oct	59	7.99	4.03	34.6	1.97	2.4	0.0019	91.5
	Nov–Dec	59	3.11		41.4	2.00	3.4	0.0043	68.3
Washington, D.C.	Jan–Feb	59	0.0	1.23	3.36	1.90	12.3	0.39	0.0
	Mar–Apr	60	0.0	0.97	3.25	2.11	4.7	0.17	0.0
	May–Jun	63	0.0	0.87	2.93	1.98	2.4	0.10	0.0
	Jul–Aug	58	0.0	1.12	2.94	2.09	4.1	0.14	0.0
	Sep–Oct	63	8.74	3.88	34.2	1.90	6.7	0.0062	120.
	Nov–Dec	56	2.50		44.3	1.90	1.2	0.0017	87.9
Miami, Florida	Jan–Feb	61	0.0	1.17	3.69	1.52	3.5	0.10	0.0
	Mar–Apr	60	0.0	1.00	3.38	1.65	2.2	0.08	0.0
	May–Jun	62	0.0	1.00	3.25	1.89	2.4	0.10	0.0
	Jul–Aug	51	0.0	0.75	2.70	1.52	4.1	0.18	0.0
	Sep–Oct	63	9.49	4.51	26.4	1.13	1.5	0.0020	101.
	Nov–Dec	56	4.14		37.0	0.76	3.0	0.0006	65.0
Mauna Loa, Hawaii	Jan–Feb	59	0.0	1.10	3.18	1.76	3.9	0.14	0.0
	Mar–Apr	60	0.0	1.30	4.15	1.87	1.9	0.074	0.0
	May–Jun	63	0.0	1.12	2.89	1.82	2.2	0.090	0.0
	Jul–Aug	59	0.0	0.88	2.77	1.95	3.1	0.14	0.0
	Sep–Oct	53	7.23	2.78	10.8	1.89	3.5	0.0084	34.4
	Nov–Dec	56	3.05		39.6	1.70	0.34	0.0005	84.3
Miraflores, Panama Canal Zone	Jan–Feb	59	1.63	1.28	4.07	1.75	2.5	0.021	3.4
	Mar–Apr	60	1.1	0.88	3.21	1.60	3.8	0.095	0.0
	May–Jun	63	0.0	0.95	3.11	1.82	6.8	0.17	0.0
	Jul–Aug	59	0.0	0.83	2.74	1.60	11.2	0.25	0.0
	Sep–Oct	63	6.4	2.36	4.02	2.27	10.3	0.06	12.0
	Nov–Dec	55	3.80	2.59	36.1	1.09	0.89	0.0611	72.7
Guayaquil, Ecuador	Jan–Feb	53	[a] 2.0	0.58	3.33	2.25	26.	0.45	[a] 6.2
	Mar–Apr	59	0.0	1.03	2.90	2.49	33.	0.54	0.0
	May–Jun	33	0.0	1.09	2.91	1.85	21.	0.45	0.0
	Jul–Aug	56	0.0	0.79	2.11	2.02	33.	0.78	0.0
	Sep–Oct	63	[a] 0.2	0.74	1.97	2.06	15.2	0.51	0.0
	Nov–Dec	62	2.25	1.99	5.94	2.22	9.9	0.18	9.7
Lima, Peru	Jan–Feb	51	0.0	1.25	2.69	1.83	3.5	0.14	0.0
	Mar–Apr	60	0.0	1.21	2.47	1.99	1.8	0.06	0.0
	May–Jun	63	0.0	1.15	2.49	0.99	4.0	0.14	0.0
	Jul–Aug	52	0.0	1.03	2.29	1.52	2.8	0.12	0.0
	Sep–Oct	61	0.0	0.96	2.21	1.63	1.2	0.09	0.0
	Nov–Dec	64	1.00	1.25	2.70	1.78	1.9	0.08	2.4
Chacaltaya, Bolivia	Jan–Feb	51	0.0	1.21	3.01	2.34	19.2	0.37	0.0
	Mar–Apr	54	0.0	1.01	2.54	2.19	13.4	0.34	0.0
	May–Jun	51	0.0	1.07	2.39	2.22	17.0	0.43	0.0
	Jul–Aug	63	0.0	0.89	2.37	1.89	7.9	0.35	0.0
	Sep–Oct	62	[a] 0.6	0.87	2.04	1.84	7.8	0.29	0.0
	Nov–Dec	63	1.6	1.56	3.67	1.87	7.6	0.14	4.2
Antofagasta, Chile	Jan–Feb	43	0.0	1.21	2.78	1.51	2.7	0.11	0.0
	Mar–Apr	60	0.0	1.04	2.72	2.13	9.9	0.43	0.0
	May–Jun	60	0.0	1.01	2.57	1.97	12.5	0.48	0.0
	Jul–Aug	52	0.0	0.93	2.47	1.79	2.4	0.14	0.0
	Sep–Oct	63	[a] 0.6	0.97	2.32	2.02	0.89	0.06	0.0
	Nov–Dec	63	0.8	1.00	2.66	1.81	1.01	0.037	1.5
Santiago, Chile	Jan	25	0.0	1.11	2.78	2.03	1.8	0.10	0.0
	Mar–Apr [b]								
	May	31	0.0	1.24	2.44	1.50	10.0	0.35	0.0
	Jul–Aug [c]								
	Sep–Oct	63	0.0	0.69	2.33	2.17	1.9	0.12	0.0
	Nov–Dec	63	[a] 0.11	0.74	1.84	2.03	2.5	0.13	[a] 0.4
Puerto Montt, Chile	Jan–Feb [b]								
	Mar–Apr [c]								
	May–Jun [c]								
	Jul–Aug	54	0.0	0.98	2.16	1.45	2.7	0.15	0.0
	Sep–Oct	63	0.0	0.82	1.93	1.13	1.05	0.07	0.0
	Nov–Dec	63	0.0	0.82	1.83	1.58	0.50	0.04	[a] 0.4
Punta Arenas, Chile	Jan–Feb	47	0.0	1.14	2.64	2.00	0.87	0.04	0.0
	Mar–Apr	60	0.0	0.96	2.29	1.95	0.20	0.012	0.0
	May–Jun	44	0.0	1.14	2.48	1.94	1.45	0.05	0.0
	Aug–Sep	55	0.0	0.87	2.07	1.80	1.25	0.06	0.0
	Oct	35	0.0	0.65	1.62	1.96	1.09	0.07	0.0
	Nov–Dec	56	[a] 0.5	0.75	1.68	2.02	1.14	0.06	[a] 0.8

[a] Value uncertain—error exceeds 10 percent.
[b] No samples received.
[c] Insufficient samples received.

per day. Sampling was conducted on a weekly basis during most of 1961 with filters changed every Monday after 7 days exposure. These filters were returned to NRL by air for assay for gross beta activity and subsequently for radiochemical analysis.

Radiochemical analyses were performed bimonthly on samples from each site (except San Juan) for the following radioisotopes: Sr^{89}, Sr^{90}, Y^{91}, Cs^{137}, Ce^{141}, Ce^{144}, Pm^{147} and Pb^{210}. After dissolution of the sample and addition of carrier elements, classical chemical separation schemes were employed followed by elaborate radiochemical purification procedures (*1*). Counting of beta activity was done with halogen-filled or flow-type Geiger counters which had been standardized against calibrated samples of the same size and weight having known disintegration rates of radioisotopes of various beta (maximum) energies. Decay and absorption measurements were made as occasion demanded.

The results of the radiochemical analyses are presented in table 1 in units of micromicrocuries per cubic meter of standard air. Some of the activity ratios of current interest appear in table 2 (*2*). All radioactivity results except for the gross beta measurements have been corrected for decay to the midpoint of the collection period.

Gross Fission Products in the Air

The gross beta activity of the individual samples and the monthly profiles of radioactivity vs. latitude along the 80th Meridian have been reported in previous issues of *Radiological Health Data*. Some of these data have been replotted in figure 1 to show the progressive changes that have occurred in the gross fission product concentrations in the air at Washington, D.C., Miami, Fla., and Antofagasta, Chile during the period 1959–1961. The increases in activity during the spring season are evident at the two Northern Hemisphere sites but are less obvious at Antofagasta. The 1961 U.S.S.R. tests caused a hundred-fold increase in radioactivity at Washington and Miami, with activity levels at these two sites approximating those observed following the fall 1958 series of high yield nuclear tests in the U.S.S.R.

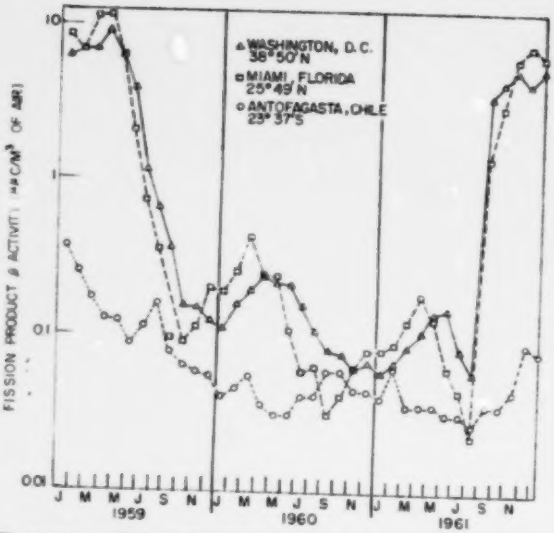

FIGURE 1.—PROGRESSIVE CHANGES IN THE CONCENTRATION OF GROSS FISSION PRODUCTS IN THE AIR AT WASHINGTON, MIAMI AND ANTOFAGASTA, 1959–1961

The only effect of the French nuclear testing program at the above sites was an increase in activity at Miami in March 1960 following the first test in the Sahara Desert on February 13, 1960. None of the other tests there produced any identifiable change in the gross beta activity at these three sites, although activity from the test of December 27, 1960 was detected for a short time at Miraflores, Panama Canal Zone and San Juan, Puerto Rico in January 1961.

Strontium–90 in the Air at Ground Level

The strontium–90 concentrations in the air of the Northern Hemisphere were generally lower in 1961 (prior to the 1961 U.S.S.R. tests) than in the previous year but the rate of decrease during the period 1960 to 1961 was significantly lower than during 1959 to 1960. The changes in the strontium–90 concentrations that have occurred at four sites in the North Temperate Zone during the period January 1959 through February 1962 are shown in figure 2. The spring maxima in stratospheric deposition are evident in each of the years 1959, 1960 and 1961 with relatively little difference indicated between the latter two years. The great increase in the strontium–90 concentration following resumption of nuclear testing by the U.S.S.R. in September 1961 is apparent with strontium-90 levels approaching those of the 1958–1959 period. The delay in appearance of the highest concentrations of strontium-90 in the ground level air until early 1962 indicates that the major part of this

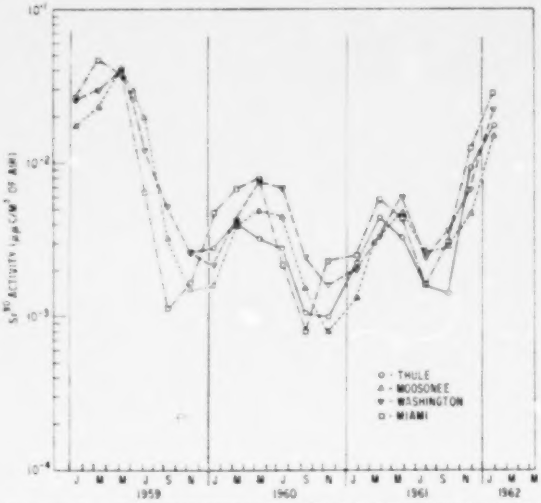

FIGURE 2.—CONCENTRATIONS OF STRONTIUM-90 IN THE AIR OF THE NORTH TEMPERATE ZONE, 1959–1961

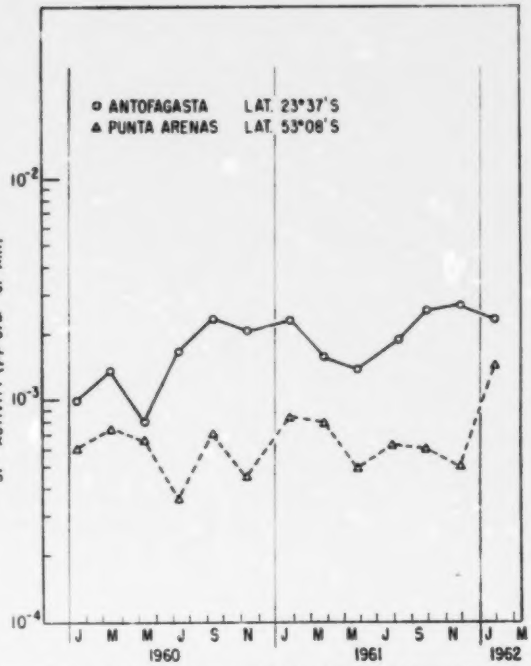

FIGURE 3.—CONCENTRATIONS OF STRONTIUM-90 IN THE AIR AT ANTOFAGASTA AND PUNTA ARENAS, CHILE, 1960–1961

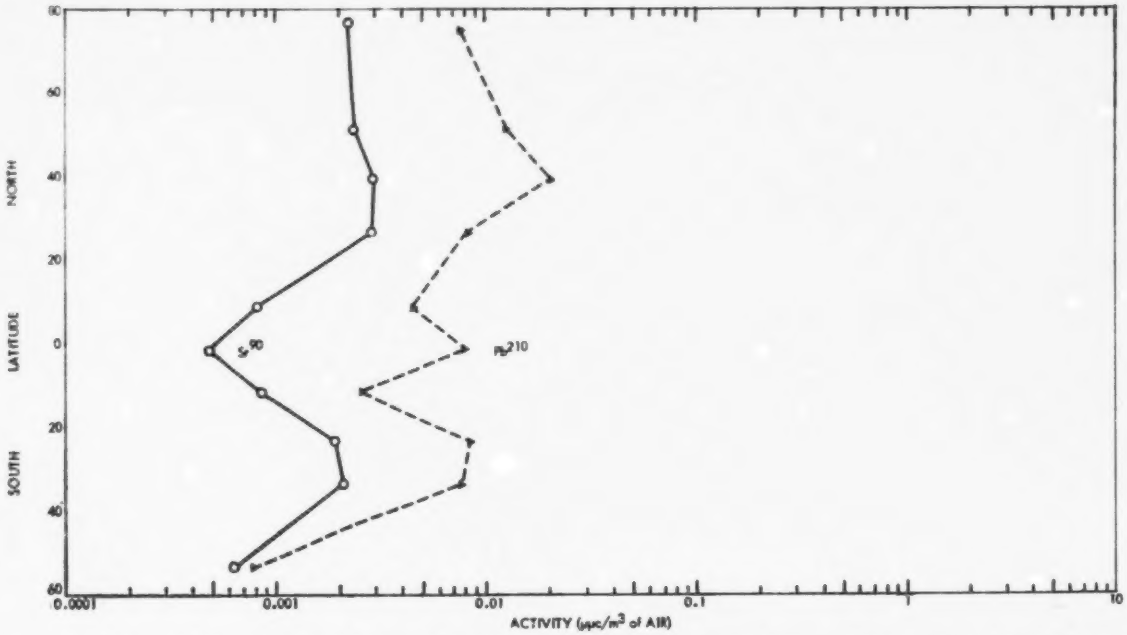

FIGURE 4.—PROFILES OF AVERAGE STRONTIUM-90 AND LEAD-210 CONCENTRATIONS DURING THE PERIOD SEPTEMBER 1960–AUGUST 1961

debris was injected directly into the stratosphere.

The strontium–90 concentrations at Antofagasta and Punta Arenas, Chile (see figure 3) show a gradual increase during the period 1960 through 1961 with definite indications of spring maxima in activity at Antofagasta. The peak-to-trough ratio is not as great there as at the Northern Hemisphere sites; at Punta Arenas there appears to be a more random fluctuation of activity with time.

Lead–210 in the Air

Lead–210, a natural radioactive isotope resulting from decay of radon in the air, has been measured in air filter collections during the past several years. Large month-to-month variations have been observed as well as a definite latitude dependence of lead–210 concentration which resembles that of strontium–90. During the year September 1960 to August 1961, the lead–210 content of air was generally much higher than its strontium–90 content at all sites, as indicated in the strontium–90 and lead–210 profiles shown in figure 4.

Activity Ratios

Under certain conditions the relative concentrations of radioisotopes can be used to determine the age of debris appearing at the different sites; generally, due to the mixing of debris from various sources, this "apparent" age is often of limited usefulness in identifying the source. This is a real problem in the bimonthly collections particularly when more or less coherent clouds of radioactivity are passing rather rapidly over the collecting sites. The variations in the relative concentrations

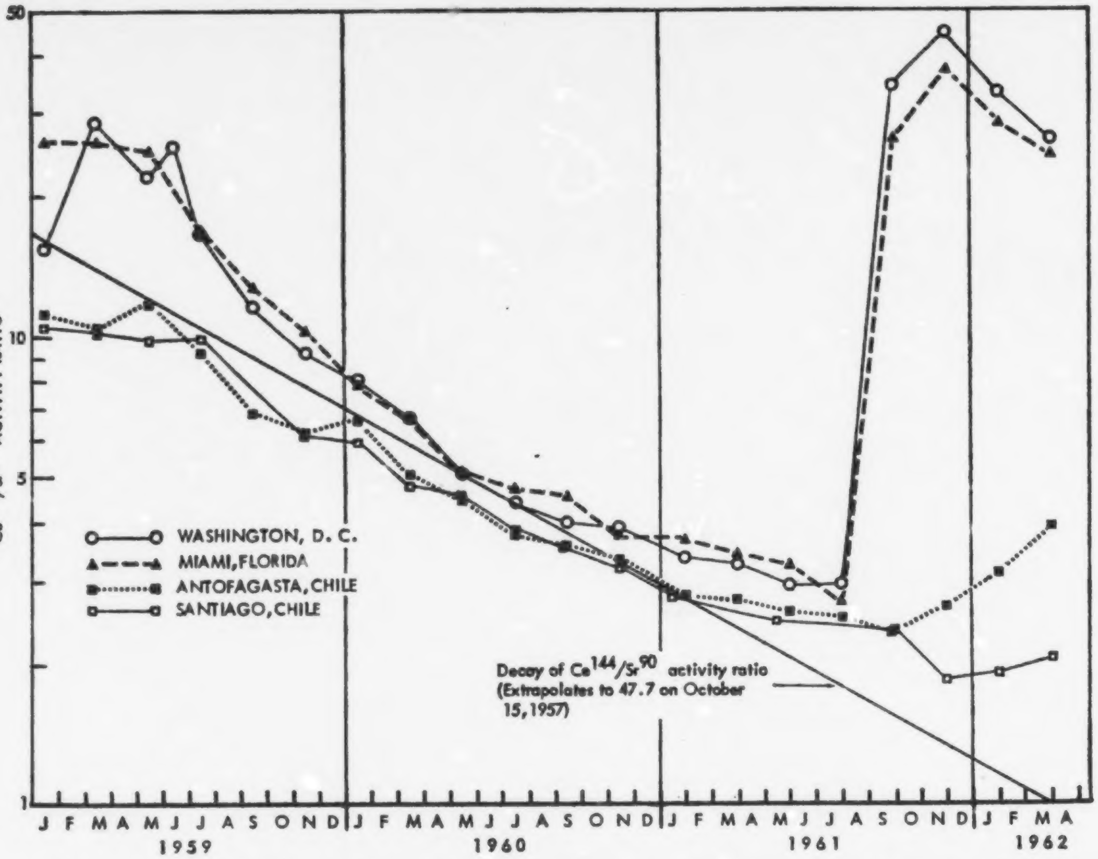

FIGURE 5.—RATIOS OF CERIUM–144 TO STRONTIUM–90 ACTIVITY AT VARIOUS SITES DURING THE PERIOD 1959–1961

of individual radioisotopes, however, can indicate whether the sources of debris at the different sites are the same or different.

An example of the changes in isotope ratios with time is given in figure 5, where the Ce^{141}/Sr^{90} activity ratios for a number of sites are shown for the period 1959–1961. The apparent aging of the debris in the Northern Hemisphere during 1959–1960 is due to the more rapid deposition of the younger debris. In contrast, the apparent decrease in age during the period 1960–1961 in both hemispheres must be due to the influx from the stratosphere of debris younger than the average. Since this change is effective in both hemispheres it must be due to debris introduced high into the stratosphere over the tropics, presumably from the "Teak" and "Orange" shots of the U.S. Hardtack series. The abrupt change occurring in late 1961 at the Northern Hemisphere sites is, of course, due to the fall 1961 series of high yield tests in the U.S.S.R.

In most respects the cesium–137 activity concentrations parallel those of the strontium–90 concentrations but are about 1.9 times as high. Variations in the cesium–137 concentrations relative to strontium–90 and to that of other activities at a few sites indicate that fractionation of cesium–137 has occurred either in nature or in the sampling and analytical process. The Ce^{144}/Pm^{147} concentrations show a progressive change with time that suggests generally uniform mixing of these isotopes prior to the time of influx of fresh debris from the 1961 U.S.S.R. tests. Promethium–147 is not as useful as cerium–144 in such measurements, however, because of the larger errors inherent in measuring the low energy beta activity emitted by promethium–147.

Following the resumption of large scale testing by the U.S.S.R. in September 1961, such isotopes as Ce^{141}, Sr^{89} and Y^{91}, which had been absent from collections for many months, appeared in quantity at the Northern Hemisphere sites. The ratios of these isotopes to each other and to longer lived isotopes indicated the youthfulness of the debris; however, due to the length of the collections reported here and the close spacing of the nuclear tests, no assignment of debris to particular tests is warranted.

An indication of the relative quantities of fresh and old debris appearing at the various sites during November–December 1961 is given in figure 6, where the latitudinal profiles of cerium–141 (33.1-day half-life), strontium–89 (50.5-day half-life), and strontium–90 (27.7 year half-life) concentrations along the 80th Meridian are shown. The highest concentrations of cerium–141 and strontium–89 in the Southern Hemisphere were at Guayaquil and in the neighborhood of Chacaltaya and Antofagasta, where they were less than 1 percent of those observed at similar latitudes in the north. Similar results were obtained from collections made in early 1962. Transequatorial mixing to this extent is not unexpected since a similar transfer of debris from the first French test in the Sahara at 27° north latitude to the Southern Hemisphere has been observed (*3*).

Summary

Prior to September 1961 the fission product content of the tropospheric air in the Northern Hemisphere continued at a decreasing rate the downward trend observed since 1959, with well-defined seasonal increases associated with the spring maximum in transport of debris from the stratospheric reservoir. In the Southern Hemisphere, seasonal variations were not so pronounced and a trend toward increasing air concentrations of long-lived fission products was observed. There were suggestions from changes in certain activity ratios that debris from the high altitude shots of 1958 was appearing in both hemispheres.

The resumption of nuclear testing by the U.S.S.R. in September 1961 caused an immediate hundredfold increase in the gross beta activity in the Northern Hemisphere; the increase in strontium–90 was more gradual and reached a maximum in early 1962, where its concentration was about ten times that of the previous year. Use of the shorter-lived fission products as tracers indicated a small but measurable transfer of activity to the Southern Hemisphere with a large gradient in activity near the equator.

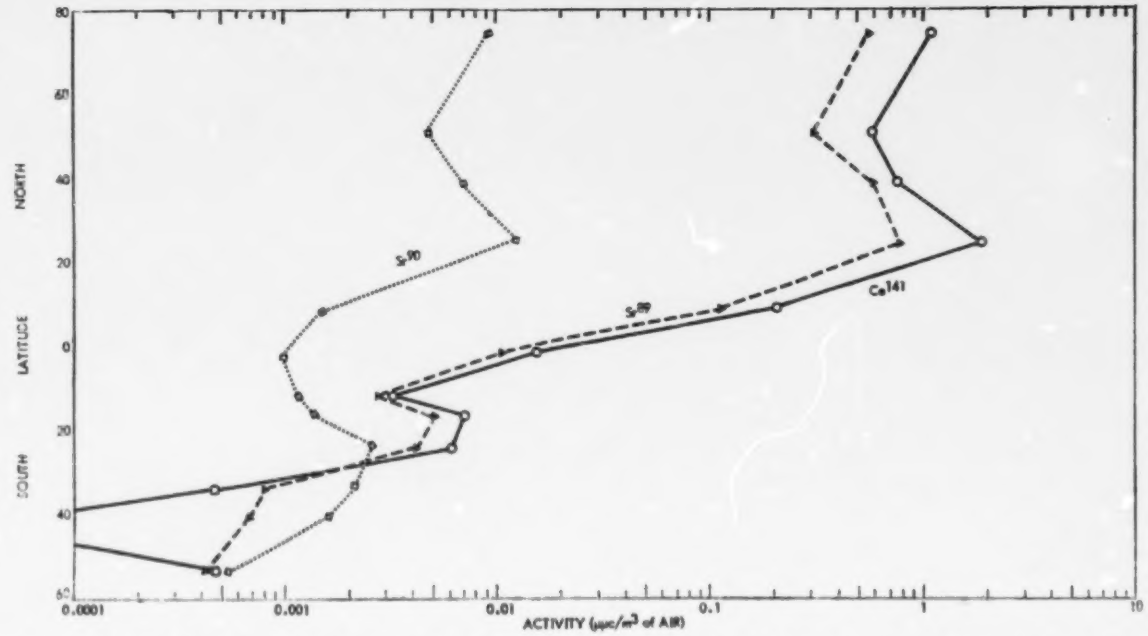

FIGURE 6.—PROFILES OF THE ACTIVITY CONCENTRATIONS OF CERIUM-141, STRONTIUM-89 AND STRONTIUM-90 IN THE AIR AT GROUND LEVEL ALONG THE 80TH MERIDIAN (WEST) DURING THE PERIOD NOVEMBER-DECEMBER 1961

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SECTION II.—FOOD

Stable Strontium in Tri-City Di

February–July 1961

Joseph Rivera
Health and Safety Laboratory, U.S. Atomic Energy Commission

One facet of the program of investigation at the Health and Safety Laboratory on the passage of strontium-90 through food chains to man has been the determination of the concentrations of stable strontium present in the various components of the food chain and in man's skeleton. To obtain part of this information, three sets of ashed foods, consisting of 19 samples each from the Health and Safety Laboratory's Tri-City Diet Studies (*1*), were analyzed for stable strontium to estimate the yearly intake of this element by residents of New York City, Chicago, and San Francisco. The results of the analyses and the estimate of annual dietary intake are presented in table 1. In general, the greatest contributions of stable strontium to the diet were from milk and fresh fruit.

TABLE 1.—STABLE STRONTIUM LEVELS OF DIET

Food Category	Consumption (kg/yr)	New York City February 1961		San Francisco March 1961		Chicago July 1961	
		Concentration (mg Sr/kg food)*	Intake (mg Sr/yr)	Concentration (mg Sr/kg food)*	Intake (mg Sr/yr)	Concentration (mg Sr/kg food)*	Intake (mg Sr/yr)
Bread, white	37	2.06	76.3	2.15	79.7	2.38	88.1
Bread, whole wheat	11	2.24	24.6	2.68	29.5	2.64	29.0
Eggs	16	1.26	19.1	1.31	20.9	1.29	20.6
Vegetables, fresh	43	1.53	65.8	2.32	99.8	1.67	71.8
Vegetables, root	17	2.30	39.1	5.04	85.7	4.37	74.3
Milk	221	0.38	82.9	1.00	220.8	0.30	66.3
Chicken	17	0.33	5.6	0.23	3.9	0.22	3.7
Fish, fresh	8	9.43	75.4	3.45	27.6	2.16	17.3
Flour	43	0.51	22.1	0.64	27.7	0.78	33.5
Macaroni	3	0.48	1.4	0.88	2.6	0.59	1.8
Rice	3	0.19	0.6	0.21	0.6	0.19	0.6
Meat	73	0.18	13.0	0.19	14.0	0.21	15.3
Fish, shell	1	18.17	18.2	3.59	3.6	5.39	5.4
Beans, dried	3	2.81	8.4	3.47	10.4	3.29	11.1
Fruit, fresh	68	1.09	73.8	8.82	599.8	0.07	354.2
Potatoes	45	0.31	14.1	1.09	48.8	0.67	30.2
Fruit, canned	26	0.36	9.3	0.26	6.7	0.23	6.0
Fruit, juices	19	0.37	7.1	0.45	8.3	1.09	20.7
Vegetables, canned	20	1.54	30.7	0.32	6.4	1.88	37.6
Total diet	674	0.872	587.5	1.92	1,296.8	1.32	887.5

* Fresh weight

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* Data from *Quarterly Summary Report, HASL-131,* October 1, 1962.

Most of the analyses were done by emission spectroscopy by a commercial laboratory. The average difference between a large number of blind duplicate samples analyzed by this laboratory was ± 5 percent. Many of the samples were also analyzed by other laboratories using different methods (flame photometry and neutron activation analysis). All results agreed to within 10 percent except for a few isolated cases.

Assuming an average annual calcium intake of 383 grams (*2*) and using the data in table 1, the ratio of stable strontium to calcium in the average diet is found to be 1.5 mg Sr/g Ca, 2.3 mg Sr/g Ca, and 3.4 mg Sr/g Ca in New York City, Chicago, and San Francisco diets, respectively. These results may be compared with the estimates of 1.3 mg Sr/g Ca for diets in the United Kingdom (*3*), 1.3 mg Sr/g Ca for diets in Canada (*4*), and 1.2 mg Sr/g Ca for a typical Danish diet (*5*).

The Danish study showed that there was a seasonal variation in the dietary intake of stable strontium of a factor of two between the spring and autumn, the intake during the spring being greater. Preliminary measurements at this laboratory show considerable variability in the stable strontium content of some foods purchased at different times. In view of these findings, the estimates of stable strontium intake in the three cities presented here should be taken as provisional since more measurements of samples collected throughout the year will have to be made before a true yearly average intake can be computed.

If the dietary intake of stable strontium in New York City does differ from that in San Francisco by about a factor of two, as it now appears, then one would expect stable strontium levels in bone samples obtained from deceased residents of these cities to also differ by a factor of two. Measurements of stable strontium in human bone samples from these cities are now being made, in addition to the analyses of foods, to see if this is the case. The data will also be used to calculate the ratio Sr/Ca in diet to Sr/Ca in bone (Observed Ratio) and to see if this Observed Ratio varies with the total dietary strontium intake.

Previous coverage in *Radiological Health Data:*

Period	Issue
Third sampling (October 1960–January 1961)	*October 1961*
Fourth sampling (February–April 1961)	*December 1961*
Fifth sampling (May–July 1961)	*March 1962*
Sixth sampling (August–October 1961)	*June 1962*
Seventh sampling (November 1961–February 1962)	*September 1962*
August–October 1961 (stable strontium and strontium-90)	*November 1962*
November 1961–February 1962 (strontium-90)	*January 1963*

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Cesium–137 and Strontium–90 in Foods

1960–1962

Division of Pharmacology, Food and Drug Administration

As a part of a continuing program for surveillance of foodstuffs by the Food and Drug Administration (FDA), cesium–137 analyses are performed on about 10 percent of all samples analyzed for strontium–90. Details of the overall program have previously been described (*1*). The unashed samples are split, with one-half being assayed in the Washington, D.C. laboratory for cesium–137 and one-half being assayed in the respective FDA District laboratory for strontium–90.

Cesium–137 Analysis

The sample splits to be analyzed for cesium–137 are chopped up or slurried without ashing or further chemical preparation and placed in a 3.7-liter Marinelli beaker. The beaker with its slurried contents is placed directly over a 3 x 3-inch sodium iodide crystal and counted for 1000 minutes with a 400-channel (0–2 Mev) gamma spectrometer previously calibrated with a cesium–137 standard. By integrating the number of counts in the peak characteristic of cesium–137 (0.66 Mev), and subtracting for background and the influence of adjacent peaks, the concentration of cesium–137 in the sample can be determined.

Strontium–90 Analysis

The sample splits to be analyzed for strontium–90 are ashed at 550–600° C and dissolved in hydrochloric acid. Calcium and strontium are precipitated as oxalates and separated with concentrated nitric acid. Radium is removed with barium chromate, and the lanthanides are removed with yttrium hydroxide. Strontium–90 is then determined by isolation of the yttrium–90 daughter product at secular equilibrium. The direct measurement of strontium–90 with correction for ingrowth of yttrium–90 is not used since it does not differentiate between strontium–90 and strontium–89, which are part of the fresh fallout in the environment following nuclear weapons testing.

Results

The results of 182 analyses for cesium–137 and, where available, the corresponding strontium–90 results are presented in table 1. Also included is the ratio of cesium–137 to strontium–90 to the nearest whole number. Because of the relatively small number of samples for individual food items, it is not possible to draw any inferences regarding geographical and temporal relationships. The effect of processing on the cesium–137 and strontium–90 content of vegetables is shown in table 2. Again, the number of samples is small. Table 3 presents the distribution of cesium–137 and strontium–90 in plant parts.

Discussion

Generally, the cesium–137 concentration in foods is higher than the strontium–90 concentration. The only exception is cassia (cinnamon bark). Also, there is a rough correlation of cesium–137 with strontium–90, i.e. in some products when the strontium–90 content is high, the cesium–137 content is high. However, it should be noted that this correlation is at best approximate and that exceptions appear upon closer scrutiny. The cesium–137—strontium–90 ratio can be observed to vary widely.

Among the vegetables, the green leafy varieties contain more cesium–137 than other products. The strontium–90 content of these same varieties is also high.

Corn contains the lowest cesium–137 and strontium–90 concentrations among all grains analyzed. Barley, rice, and rye contain the highest concentrations of cesium–137, and wheat contains the highest strontium–90 concentrations.

Among the beverage products, tea leaves contain the most cesium–137 and strontium–90.* Cacao beans contain about the same

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* FDA studies indicate an extraction factor of 0.2 for strontium–90 in tea. Two grams of tea (the usual amount used in brewing a cup), containing the maximum nuclide content in table 1, would yield 0.4 pc of strontium–90 per cup of liquid tea. At present, studies are under way to determine the extraction factor for cesium–137 in tea.

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TABLE 1.—CESIUM-137 AND STRONTIUM-90 IN FOODS

Variety	Number of samples	Cesium-137 (pc/kg)		Strontium-90 (pc/kg)		Cs^{137}/Sr^{90} [a]
		Average	Range	Average	Range	
Vegetables						
Beans, kidney (dried)	4	288	276- 311	3.0	2.2- 3.0	96
Beans, lima	3	159	119- 210	12	1.0- 28	13
Beans, navy	1	1943	[b]	[c]—		
Beans, pinto (dried)	2	292	276- 307	6.0		49
Beans, snap	3	50	36- 70	22	14 - 30	2
Blackeyed peas	3	250	195- 309	1.0		250
Broccoli	2	148	111- 185	12	10 - 14	12
Brussel sprouts	1	125		6.0		21
Cabbage	5	437	[d]ND-1030	6.0	4.0- 9.0	73
Collards	1	511		47		109
Mustard greens	1	3990		91		44
Parsley	3	4680	3210-5540	86	64 - 127	55
Peas (canned)	1	31		1.0		31
Soybeans	6	446	303- 674	26	18 - 34	17
Spinach	5	1800	569-3180	40	32 - 55	45
Root vegetables						
Carrots	1	51		—		
Potatoes, sweet	1	107		5		21
Potatoes, white	2	104	73- 135	1.0		104
Turnips	1	413		5.4		77
Fruits						
Apples	1	44		—		
Cherries	1	236		—		
Cranberries	1	562		—		
Dates	2	141	130- 152	—		
Figs	4	189	168- 237	7.7	7.0- 9.0	25
Grapefruit	1	51		1.0		51
Nectarines	1	57		—		
Oranges	2	96	51- 140	3.0		32
Peaches (canned)	1	553		0.2		2765
Pumpkin	1	90		2.7		33
Raspberries (red)	1	372		—		
Tomatoes	1	38		—		
Grains						
Barley	5	204	159- 228	15.6	7.0- 23	13
Corn	8	88	71- 120	1.2	0.2- 3.7	73
Oats	7	122	87- 150	15	4.8- 26	8
Rice	1	329		2.5		132
Rye	5	203	157- 243	14		14
Wheat	11	178	76- 561	17	0.9- 53	10
Eggs						
Shells	1	1170		390		3
Substance	3	19	3- 27	1.5	0.7- 2.4	13

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TABLE 1.—CESIUM-137 AND STRONTIUM-90 IN FOODS—Continued

Variety	Number of samples	Cesium-137 (pc/kg)		Strontium-90 (pc/kg)		Cs^{137}/Sr^{90} [a]
		Average	Range	Average	Range	
Seafoods						
Clams	1	153		0.5		306
Crabmeat	1	120		—		
Haddock	1	40		—		
Sardines	2	87	80- 94	0.9		97
Shrimp	1	6.0		1.2		5
Tuna (canned)	3	105	73- 123	0.2	0.1- 0.4	525
Beverage products						
Cacao beans	2	540	323- 757	15	12 - 18	36
Coffee	7	431	320- 652	12	5.4- 25	36
Tea	9	1770	924-4960	299	29 -1034	6
Nuts						
Brazil nuts	2	942	705-1180	77		12
Peanuts	2	168	111- 226	58		3
Pecans	7	419	230- 860	29		14
Walnuts	1	112		1.2		93
Spices						
Cassia	1	1130		2590		0.4
Cardamom	2	843	765- 921	160	98 - 223	5
Cloves	2	1320	1140-1490	—		
Hops (dried)	1	633		50		13
Mustard seed	4	246	168- 410	54	32 - 92	5
Thyme leaves	1	3150		885		4

[a] Calculated to the nearest whole number.

[b] Blank indicates no variance.

[c] Dash indicates no strontium-90 analysis was done.

[d] ND indicates cesium-137 not detectable.

TABLE 2.—EFFECT OF PROCESSING ON CESIUM-137 AND STRONTIUM-90 CONTENT

	Broccoli		Spinach	
	Raw	Canned	Raw	Frozen
Number of samples	2	2	2	2
Cesium-137 (pc/kg)				
average	148	67	1415	905
range	111-185	47 -87	569- 2,260	240-1,570
Strontium-90 (pc/kg)				
average	12	7.5	43.5	25.5
range	10- 14	5 -10	32 - 55	15- 36

TABLE 3.—DISTRIBUTION OF CESIUM-137 AND STRONTIUM-90 IN PLANT PARTS

Product	Cesium-137			Strontium-90		
	Average (pc/kg)	Range (pc/kg)	Number of samples	Average (pc/kg)	Range (pc/kg)	Number of samples
Apples						
core	[a]—			3.8	0.8- 14	14
flesh	—			0.8	0.1- 2.6	15
peel	—			1.4	0.6- 3.5	8
Beans, lima						
beans	134	119-149	2	8.5	0.6- 28	25
pods	52	46- 57	2	44	3.7-172	25
Corn						
kernel	83	72- 90	3	0.9	0.3- 1.4	3
meal	73	35-105	3	3.0	0.0- 6.0	2
Eggs						
shells	1170		1	390		1
substance	3		1	1.5		1
Rice						
paddy	329		1	2.5		1
milled	22		1	0.2		1
Wheat						
berry	115	80-150	2	25	3.3- 58	25
bran	369	273-465	2	64	9.6-136	24
flour	45	31- 59	2	5.5	0.6- 24	25

[a] Dash indicates cesium-137 analysis was not done.

amounts of cesium-137 and strontium-90 as coffee beans.

Brazil nuts contain the most cesium-137 and strontium-90 of all the nuts analyzed. The one sample of walnuts contained the least concentrations of both radionuclides.

Of the spices analyzed, thyme leaves are highest in cesium-137, followed by cloves and cassia. Cassia contains the most strontium-90, followed by thyme leaves. The spice products contribute very little to the radionuclide intake in the total diet.

Table 2 shows in a limited respect the effect of processing on the cesium-137 and strontium-90 content of two vegetables items. In both cases the steps in processing reduce the radionuclide content by over 20 percent.

Table 3 shows the distribution of cesium-137 and strontium-90 in plant parts. Cesium-137 analyses are not available for apples. In all cases, except lima bean pods, the cesium-137 concentration is higher than the strontium-90 concentration in the same plant part. It can be theorized that while the cesium-137 in the pods is a result of direct deposition of fallout, the cesium-137 in the bean resulted from translocation. It is important to note that the bean has a high potassium content, as does most seed tissue. Cesium-137 follows the metabolic pathways of potassium.

Of interest is the observation that the distribution of cesium-137 between eggshells and egg substance is similar to the distribution of strontium-90 between eggshells and egg substance. In each case, the concentration of nuclide in the shell is much greater than that in the substance.

Summary

The results of analyses for cesium-137 in a number of food items are presented with available strontium–90 analyses on the same sample. In general, the cesium–137 concentration is higher than the strontium–90 concentration. The effect of washing and other procedures in the preparation of the canned or frozen product is tabulated. The distribution of cesium–137 in plant parts follows the same general relationship as strontium–90 except in those tissues high in potassium.

Recent coverage in *Radiological Health Data:*

Period	Issue
1960 and 1962	*May 1962*
1961	*June 1962*
1960–1962	*August 1962*
1960–1962	*September 1962*
1959–1961 (Baby Food)	*November 1962*
1960–1962	*December 1962*

REFERENCE

(*1*) Food and Drug Administration: Survey of Radioactivity in Food, *Radiological Health Data, 3*:476–81 (December 1962).

SECTION III.—MILK

Milk Surveillance

Milk has been the single food item most often used as an indicator of the population's intake of radionuclides from the environment. This is because milk is a basic constituent of the diet of the U.S. population and contains most of the radionuclides identified as being biologically important. In addition, milk is produced and consumed on a regular basis, is convenient to handle, is easily analyzed, and samples which are representative of milk consumption in any area can be readily obtained.

It should be remembered that milk is only one of many dietary sources of radionuclide intake.

PASTEURIZED MILK NETWORK
October 1962

Division of Radiological Health and
Division of Environmental Engineering and
Food Protection, Public Health Service

In 1957, the PHS began analyzing raw milk to determine relationships between dairy practices and radionuclide levels in milk. However, it became evident that the milk actually consumed by the population should be included in a broader sampling program. In 1960, the pasteurized milk network was initiated to provide data representative of the milk consumed in selected municipalities. Both raw and pasteurized milk sampling data were reported concurrently until June 1961 to permit comparison of the differences between the earlier, limited, milkshed sampling results and those exhibited in pasteurized milk monitoring. Since June 1961, raw milk sampling has been carried out for investigative rather than monitoring purposes.

During October 1962, pasteurized milk surveillance was conducted at 62 Pasteurized Milk Network stations with the cooperation of State and local milk sanitation agencies which have been shipping samples to the PHS Southwestern, Southeastern, and Northeastern Radiological Health Laboratories for analysis. Publication in *Radiological Health Data* follows 3 to 4 months after sample collection because of the time required for shipment, processing, radioanalysis of strontium, data compilation, and publication procedures. Data from gamma analyses (iodine–131) are available to State public health officials and the Federal Radiation Council within 3 days after sample collection for possible countermeasure purposes.

Sampling and Compositing Procedures

The current program emphasizes (1) measurement of the concentrations of radioactivity in samples of pasteurized milk consumed by the public in various regions of the country, and (2) provision of at least one sampling point within virtually all States and additional points when indicated by widely varying conditions of the milk supply or when needed in order to cover large population groups. Each sample is composited from subsamples collected from each plant in proportion to the relative volumes of milk sold. The objective of this sampling program is to reflect about 90 percent of each city's milk supply. Prior to September 15, 1961, the composite sample was taken from one day's sales per month and was as representative of a community's total supply as could be achieved under practical conditions. Since the resumption of nuclear weapons testing, the sampling frequency has been increased. During October 1962, most stations were sampled twice a week. All surveillance data are subject to continuing review and evaluation to observe unusual patterns or concentrations which may require immediate attention. Further atmospheric nuclear testing may require re-evaluation and adjustment of the sampling frequency and analytical schedule for this program.

Iodine-131, cesium-137, and barium-140 are determined by gamma scintillation spectroscopy,[1] while strontium-89 and strontium-90 are determined following radiochemical separation. The minimum detectable concentrations in units of μμc/liter are: Sr^{89}, 5; Sr^{90}, 1; I^{131}, 10; Cs^{137}, 5; and Ba^{140}, 10.

Table 1 presents summaries of all available analyses for October 1962. When a radionuclide is reported by a laboratory as being below the minimum detectable concentration, one-half of this value is used in calculating the monthly average. A similar procedure is used for the network average.

Discussion of the Data

The iodine-131 October 1962 monthly average concentration contour map (figure 1) is similar to the September contour map appearing in the January issue. Most of the country reported monthly averages of between 10 and 100 μμc/liter. Values of 90 to 140 μμc/liter were observed in the Great Lakes region. Palmer, Alaska, had the highest October average of 270 μμc/liter while the network average was 61 μμc/liter.

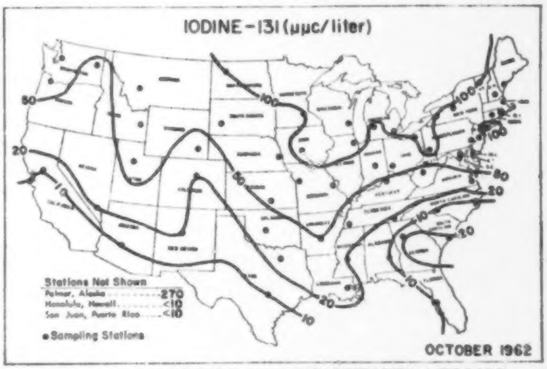
IODINE-131 (μμc/liter)
Stations Not Shown
Palmer, Alaska 270
Honolulu, Hawaii .... <10
San Juan, Puerto Rico .... <10
• Sampling Stations
OCTOBER 1962

FIGURE 1.—IODINE-131 CONCENTRATIONS IN PASTEURIZED MILK

The monthly average strontium-89 concentrations in milk for October 1962 (figure 2) increased from the previous month at a number of stations. The network average for the month was 56 μμc/liter. Monthly average concentrations slightly greater than 100 μμc/liter were noted in Minnesota, Iowa, and in the northwestern corner of the United States. Phoenix, Arizona, which very seldom shows monthly average strontium-89 concentrations greater than 20 μμc/liter, reported 50 μμc/liter for October. Palmer, Alaska reported 150 μμc/liter—the highest average for the month.

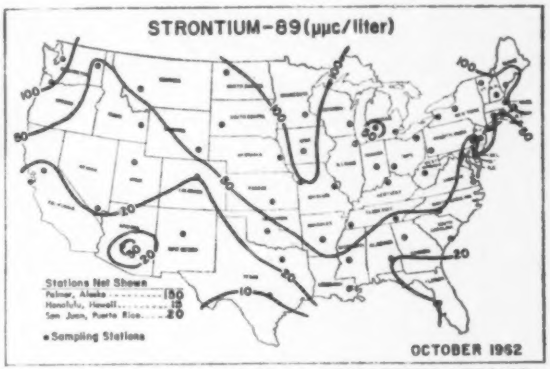
STRONTIUM-89 (μμc/liter)
Stations Not Shown
Palmer, Alaska 150
Honolulu, Hawaii 15
San Juan, Puerto Rico 20
• Sampling Stations
OCTOBER 1962

FIGURE 2.—STRONTIUM-89 CONCENTRATIONS IN PASTEURIZED MILK

The October 1962 monthly average strontium-90 concentration contour map (figure 3) appeared to be similar to the map for the previous month. The network average rose from 12 to 16 μμc/liter during October. The Southwest had concentrations below 10 μμc/liter while several northern States west of the Mississippi River reported values over 20 μμc/liter. Other areas reporting values greater than 20 μμc/liter were the lower Mississippi Valley re-

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[1] Southeastern Radiological Health Laboratory employs a radiochemical procedure for barium-140 analysis.

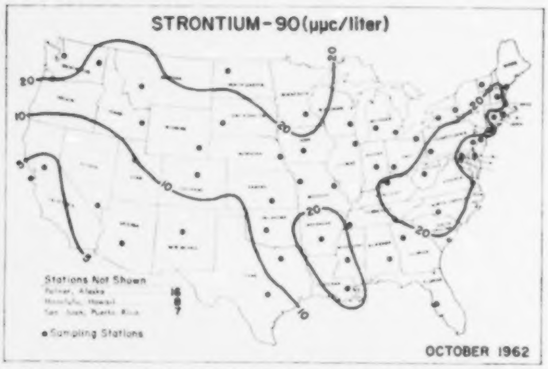
STRONTIUM-90 (μμc/liter)
20
10
5
20
10
20
20
20
10
Stations Not Shown
Palmer, Alaska
Honolulu, Hawaii
San Juan, Puerto Rico
16
8
7
Sampling Stations
OCTOBER 1962

FIGURE 3.—STRONTIUM-90 CONCENTRATIONS IN PASTEURIZED MILK

gion and the inland areas of the Atlantic seaboard States. A station high of 29 μμc/liter was noted in Seattle, Washington.

Selected Monthly Strontium-90 Profiles

In previous issues of *RHD*, the average monthly strontium-90 concentrations in pasteurized milk from selected cities in the monitoring program were published. Profiles for an additional 15 cities are presented in figure 4. These graphs show the strontium-90 concentrations in milk from selected cities in the United States Department of Agriculture marketing regions of the United States.

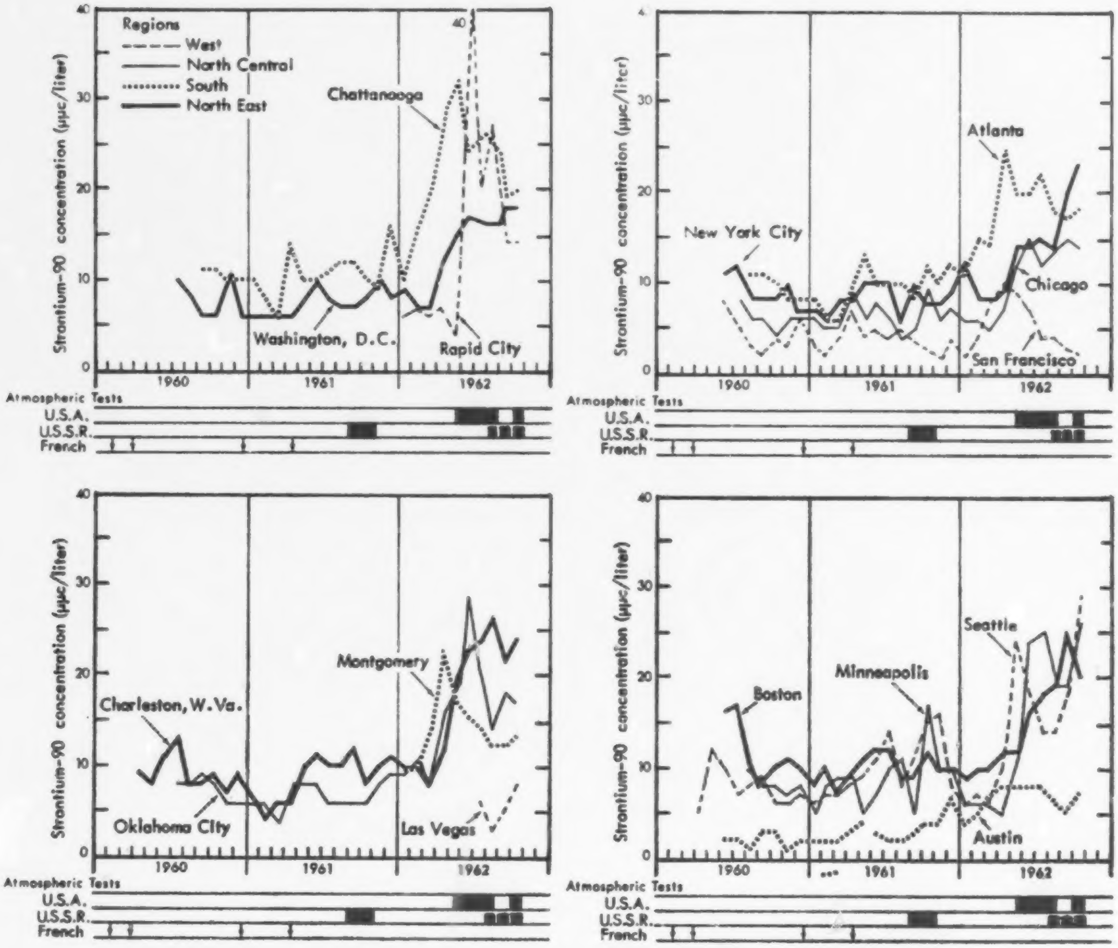

FIGURE 4.—STRONTIUM-90 CONCENTRATIONS IN PASTEURIZED MILK

TABLE 1.—RADIOACTIVITY IN PASTURIZED MILK, OCTOBER 1962

[Average radioactivity concentrations in μμc/liter]

Sampling locations	Calcium (g/liter)		Strontium-89		Strontium-90		Iodine-131		Cesium-137		Barium-140		Last Sr^{90} Profile in RHD
	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	
Ala: Montgomery	1.22	1.23	35	20	13	13	10	10	35	25	10	10	Feb. 1963
Alaska: Palmer	1.08	1.34	75	150	12	16	250	270	55	65	30	60	Nov. 1962
Ariz: Phoenix	1.08	1.31	10	50	2	7	10	10	15	20	10	<10	Jan. 1963
Ark: Little Rock	1.21	1.24	80	70	29	28	10	50	55	50	20	20	Nov. 1962
Calif: Sacramento	1.11	1.34	5	15	3	4	20	10	20	15	20	10	Dec. 1962
San Francisco	1.13	1.32	10	5	4	2	20	10	20	20	20	10	Feb. 1963
Colo: Denver	1.11	1.38	55	20	15	13	30	20	75	50	10	<10	Dec. 1962
Conn: Hartford	1.10	1.15	30	50	12	12	30	70	70	60	<10	20	Dec. 1962
Del: Wilmington	1.09	1.15	40	50	13	14	30	70	70	60	<10	20	Jan. 1963
D.C: Washington	1.16	1.16	45	50	17	18	20	60	60	50	10	20	Feb. 1963
Fla: Tampa	1.23	1.24	20	20	11	9	<10	10	145	130	<10	<10	Jan. 1963
Ga: Atlanta	1.23	1.23	45	30	19	18	20	20	55	50	10	20	Feb. 1963
Hawaii: Honolulu	1.07	1.32	10	15	4	8	10	<10	35	35	<10	10	Nov. 1962
Idaho: Idaho Falls	1.09	1.34	45	30	11	13	40	40	75	70	20	10	Jan. 1963
Ill: Chicago	1.14	1.14	35	60	14	14	50	120	60	55	<10	20	Feb. 1963
Ind: Indianapolis	1.11	1.19	40	65	16	14	30	90	40	45	<10	20	Dec. 1962
Iowa: Des Moines	1.10	1.34	80	105	14	16	60	120	40	50	20	20	Jan. 1963
Kans: Wichita	1.12	1.34	60	60	13	13	40	60	40	40	10	10	Nov. 1962
Ky: Louisville	1.19	1.20	75	65	22	24	20	40	35	30	20	30	Jan. 1963
La: New Orleans	1.22	1.26	75	45	30	24	10	30	80	50	20	20	Nov. 1962
Maine: Portland	1.15	1.13	45	75	15	19	30	60	120	120	<10	20	Jan. 1963
Md: Baltimore	1.16	1.21	40	50	18	18	20	60	60	65	<10	20	Jan. 1963
Mass: Boston	1.12	1.20	45	100	21	20	30	90	125	115	10	30	Feb. 1963
Mich: Detroit	1.10	1.16	35	70	12	16	50	120	70	70	<10	20	Dec. 1962
Grand Rapids	1.15	1.22	35	45	10	11	40	90	60	60	<10	20	Jan. 1963
Minn: Minneapolis	1.10	1.39	85	120	21	26	40	100	95	100	20	40	Feb. 1963
Miss: Jackson	1.26	1.28	70	40	21	21	10	20	45	30	20	20	Dec. 1962
Mo: Kansas City	1.07	1.33	80	100	14	17	50	80	35	40	20	30	Dec. 1962
St. Louis	1.08	1.34	60	55	16	16	40	60	40	40	20	20	Nov. 1962
Mont: Helena	1.14	1.35	80	55	15	19	50	70	85	85	20	20	Nov. 1962
Nebr: Omaha	1.12	1.33	85	70	14	13	60	80	50	50	20	20	Nov. 1962
Nev: Las Vegas	1.06	1.29	25	25	5	8	30	20	35	30	<10	10	Feb. 1963
N.H: Manchester	1.13	1.17	45	80	17	23	30	70	145	110	<10	20	Sep. 1962
N.J: Trenton	1.12	1.14	35	65	12	14	20	60	65	60	<10	20	Dec. 1962
N. Mex: Albuquerque	1.10	1.37	20	15	5	6	30	20	25	25	10	20	Nov. 1962
N.Y: Buffalo	1.10	1.12	35	65	15	14	40	90	70	75	<10	20	Dec. 1962
New York	1.08	1.16	40	85	16	23	40	130	80	90	<10	40	Feb. 1963
Syracuse	1.11	1.16	40	75	12	19	40	100	60	60	10	30	Nov. 1962
N.C: Charlotte	1.23	1.24	55	50	23	21	<10	10	50	45	10	20	Nov. 1962
N.D: Minot	1.11	1.36	100	95	22	23	80	100	80	70	20	30	Jan. 1963
Ohio: Cincinnati	1.12	1.15	45	50	13	17	40	80	40	30	<10	<10	Dec. 1962
Cleveland	1.11	1.18	30	65	14	15	40	100	55	50	<10	10	Nov. 1962
Okla: Oklahoma City	1.16	1.20	60	40	17	17	20	30	45	35	10	20	Feb. 1963
Ore: Portland	1.12	1.42	60	110	12	20	20	60	65	85	10	40	Dec. 1962
Pa: Philadelphia	1.14	1.16	30	45	14	15	30	70	70	50	<10	10	Nov. 1962
Pittsburgh	1.12	1.17	40	60	18	23	30	110	85	70	<10	20	Nov. 1962
P.R: San Juan	1.19	1.16	25	20	11	7	<10	<10	35	30	10	<10	Nov. 1962
R.I: Providence	1.11	1.15	35	60	13	19	20	70	85	80	<10	20	Jan. 1963
S.C: Charleston	1.21	1.23	45	35	20	19	10	20	65	60	<10	20	Dec. 1962
S.D: Rapid City	1.06	1.13	85	60	20	14	70	80	60	60	20	20	Feb. 1963
Tenn: Chattanooga	1.25	1.26	65	45	23	20	10	20	55	40	10	20	Feb. 1963
Memphis	1.22	1.23	60	60	21	19	10	40	25	35	20	20	Jan. 1963
Tex: Austin	1.16	1.20	15	10	6	7	<10	10	20	15	<10	<10	Feb. 1963
Dallas	1.18	1.20	40	25	14	17	10	30	30	25	<10	10	Dec. 1962
Utah: Salt Lake City	1.10	1.36	60	30	12	10	320	60	95	90	40	30	Nov. 1962
Vt: Burlington	1.10	1.11	45	90	14	14	20	100	110	85	<10	20	Dec. 1962
Va: Norfolk	1.20	1.21	55	40	22	20	10	40	75	60	<10	20	Dec. 1962
Wash: Seattle	1.10	1.38	45	105	15	29	30	60	90	95	20	40	Feb. 1963
Spokane	1.15	1.42	40	40	14	15	50	40	70	75	10	10	Dec. 1962
W. Va: Charleston	1.16	1.19	80	65	24	24	20	30	45	50	10	20	Feb. 1963
Wis: Milwaukee	1.10	1.18	30	60	9	12	50	140	60	60	<10	20	Jan. 1963
Wyo: Laramie	1.11	1.36	125	60	15	13	190	30	110	80	50	20	Jan. 1963
Network average	1.14	1.25	49	56	14.8	16.0	40	61	62	58	12	20	

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CALIFORNIA MILK NETWORK
1960–June 1962

State of California, Department of Public Health

Surveillance of the concentrations of specific radionuclides in milk is one phase of California's Department of Public Health program of radiation control, which started in 1960. Milk monitoring has been conducted by the Department's Bureau of Radiological Health, a constituent of the Division of Environmental Sanitation.

The surveillance program involves the weekly sampling of milk from 11 major milksheds (see figure 5). Originally, radioanalysis was performed for potassium–40, cesium–137, and strontium–90. More recently, interest has shifted to strontium–89, strontium–90, and iodine–131 and milk is now being analyzed for these three radionuclides only.

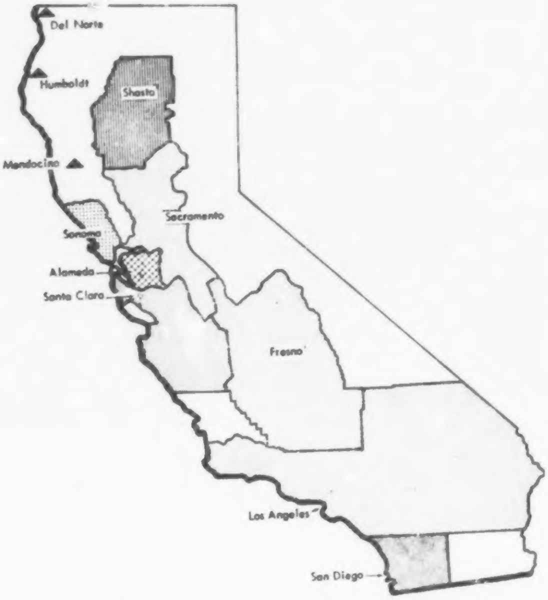

FIGURE 5.—CALIFORNIA MILKSHEDS

Results and Discussion

Table 2 summarizes the radioanalysis of milk from the 11 milksheds during the 1960–1961 period for potassium–40, cesium–137, and strontium–90. Table 3 presents strontium–89 and strontium–90 results for the same milksheds for the first six months of 1962. It should be noted that the units used in table 3 are μμc/g calcium. Comparisons of data between the two tables may be made using the approximate equivalent value of 1.1 gram of calcium per liter of milk. No iodine–131 data are given but occasional samples have indicated that only trace amounts of this radionuclide have been observed during this period.

Del Norte and Humboldt Counties have produced milk with relatively high (> 100 μμc/g calcium) strontium–89 concentrations compared to the other areas.

Del Norte County milk has the highest strontium–90 content of milk sampled in the State. The average for the first six months of 1962 is 26 μμc/liter. However, both these levels are well below those requiring protective action.

Milk from other California milksheds has exhibited much lower concentrations of strontium–90. Correlations made from data not reported here show that the level of contamination decreases generally as the total rainfall for the area decreases. Thus, as expected, the dryer southern part of the State has had less strontium–90 in milk.

Instrumentation and Methodology

Radioanalyses of the milk samples are carried out in the Sanitation and Radiation Laboratory. Counting of radiostrontium in chemically prepared samples is done in an automatic low-background anticoincidence counter. (Background counting rate is less than 1.5 counts per minute.) This system includes a hemispherical gas-flow (90 percent methane and 10 percent argon) Geiger-Mueller detector surrounded by a guard (anticoincidence) detector, about 600 pounds of steel shielding, an automatic sample changer, two scalers, and a printing-timer. The detector window thickness is 0.15 mg/cm^2. Counter efficiencies of 40 and 35 percent are realized for strontium–89 and strontium–90, respectively. The maximum capacity, using 60-minute counting times, is about 120 determinations in a normal week.

Three separate 256-channel analyzers are used for gamma pulse-height analysis. For this analysis, the 2″ x 2″ sodium iodide crystal

Table 2.—POTASSIUM-40, CESIUM-137, AND STRONTIUM-90 IN CALIFORNIA MILK BY SAMPLING AREA AND MONTH, 1960–1961

(Concentrations in $\mu\mu c$/liter)

Sampling Area	1960											
	January	February	March	April	May	June	July	August	September	October[a]	November[a]	December[a]
Fresno												
K^{40}	1,201	925	1,068	1,359	b	1,297			1,300	1,232		1,320
Cs^{137}	17	c	c	c					c	c		c
Sr^{90}	1.6	1.3	3.1	2.7	1.6	4.3	2.3	4.0	4.8	4.5	4.5	3.8
Humboldt												
K^{40}	1,196	1,045	1,173	1,170		1,120			1,413		1,160	1,190
Cs^{137}	31	35	24	26		c			c		c	c
Sr^{90}	4.2	4.9	7.3	4.4	6.3	3.1	5.3	5.1	4.3		4.4	5.7
Los Angeles												
K^{40}	1,219	1,041		1,288		1,130			1,390	1,280		1,320
Cs^{137}	18	12		4		7.8			c	c		c
Sr^{90}	2.7	2.1	4.9	1.1	1.2	1.0	3.2	2.5	1.0	3.2	2.8	3.2
Sacramento												
K^{40}		1,257	1,254	1,065	1,192				1,250			1,360
Cs^{137}		14	22	c	c				c			c
Sr^{90}	2.0	3.2	4.0	1.4	3.3	2.4	5.0	2.8	1.8	3.9	4.1	3.9
San Diego												
K^{40}	1,240	1,318	1,363	1,109	1,330				1,230	1,290		1,360
Cs^{137}	19.3	12	c	c	c				c	c		c
Sr^{90}	3.0	1.6	c	2.4	2.2	1.2	1.7	2.4	c2.4	1.7	4.1	2.9
Santa Clara												
K^{40}	1,190		1,130	1,161	1,380				1,260	1,250		
Cs^{137}	c		17	71	c				c	c		
Sr^{90}	2.7	2.3	2.9	1.1	2.6	2.1	3.3	1.9	2.4	1.4	2.7	2.0
Shasta												
K^{40}	1,241	1,274	1,297	1,249		1,189			1,686	1,240		
Cs^{137}	19	19	c	18.4		c			c	c		
Sr^{90}	2.0	3.7	2.5	3.9	2.9	3.3	4.0	5.2	5.4	2.4	2.6	2.2
Sonoma												
K^{40}	1,370		1,418	1,246					1,270		1,264	1,120
Cs^{137}	11		15	8	c				c		c	c
Sr^{90}	1.5	2.4	4.8	3.7	3.1	2.7	3.8	4.2	4.1	3.8	3.2	3.5

Sampling Area	1961											
	January	February	March	April	May	June	July	August	September	October[a]	November[a]	December[a]
Fresno												
K^{40}	1,320	1,440	1,320	1,260	1,435	1,147	1,426	1,352	1,303	1,298	1,350	1,209
Cs^{137}	c	c	c	c	c	c	c	c	c			
Sr^{90}	2.06	1.65	1.91	1.41	2.30	1.74	1.09	1.44	1.15	1.58	1.52	1.58
Humboldt												
K^{40}	1,160	1,290	1,260	1,240	1,280	1,237	1,266	1,280	1,278	1,273	1,381	1,127
Cs^{137}	c	c	c	c	c	c	c	c	c		34.2	8.11
Sr^{90}	7.70	7.18	6.84	7.96	9.13	5.77	4.30	2.80	2.58	3.50	6.95	11.28
Los Angeles												
K^{40}	1,220	1,260	1,360	1,430	1,564	1,379	1,358	2,051	1,390	1,375	1,386	1,252
Cs^{137}	c	c	c	c	c	c	c	c	c			
Sr^{90}	2.09	2.09	0.92	1.40	1.22	1.54	1.02	2.36	1.22	1.78	1.41	1.88
Sacramento												
K^{40}	1,316	1,330	1,350	1,379	1,380	1,335	1,266	1,378	1,385	1,314	1,355	1,235
Cs^{137}	c	c	c	c	c	c	c	c	c		21.2	
Sr^{90}	1.60	2.79	2.17	3.12	2.42	2.47	1.67	1.89	1.41	1.53	2.07	3.78
San Diego												
K^{40}	1,318	1,280	1,360	1,352	1,370	1,332	1,277	1,318	1,385	1,323	1,315	1,217
Cs^{137}	c	c	c	c	c	c	c	c	c			
Sr^{90}	1.44	1.41	1.70	1.08	1.62	1.26	0.67	2.57	0.74	0.83	1.64	2.80
Santa Clara												
K^{40}	1,178	1,370	1,350	1,358	1,330	1,354	1,205	1,349	1,336	1,328	1,335	1,266
Cs^{137}	c	c	c	c	c	c	c	c	c			
Sr^{90}	1.25	0.83	1.02	1.91	1.64	1.22	1.81	3.53	1.75	1.42	2.07	2.07
Shasta												
K^{40}	1,301	1,370	1,280	1,267	1,400	1,264	1,165	1,273	1,365	1,327	1,315	1,243
Cs^{137}	c	c	c	c	c	c	c	c	c			
Sr^{90}	2.52	2.69	3.35	2.95	4.03	3.60	2.22	1.50	2.02	2.68	2.67	3.32
Sonoma												
K^{40}	1,170	1,350	1,217	1,286	1,310	1,343	1,294	1,278	1,350	1,295	1,334	1,239
Cs^{137}	c	c	c	c	c	c	c	c	c			
Sr^{90}	2.94	3.13	3.08	3.65	3.97	2.34	1.86	3.92	1.77	2.35	3.74	3.65

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[a] Except during October–December 1961, a sample of milk for potassium-40 and cesium-137 analyses, or a composite sample for strontium-90 analysis, was taken from a milk distribution center in each sampling area every month.

[b] A blank space indicates no sample.

[c] No significant activity.

TABLE 3.—STRONTIUM-89 AND STRONTIUM-90 IN CALIFORNIA MILK, FIRST HALF 1962

Sampling areas	Strontium-89 (μμc/g Calcium)						Strontium-90 (μμc/g Calcium)					
	Jan	Feb	Mar	Apr	May	Jun	Jan	Feb	Mar	Apr	May	Jun
Alameda	5.9	7.6	31.8	20.3	16.2	18.3	1.7	2.3	2.9	2.7	3.0	2.6
Del Norte	[a]		307	358	27.1	80.7			16.8	30.9	31.7	19.0
Fresno	5.3	4.5	8.7	16.9	13.9	12.0	1.3	1.3	1.2	2.4	2.6	2.5
Humboldt	154	165	216	111	65.8	27.2	7.5	8.5	11.8	8.3	9.1	5.5
Los Angeles	6.4	4.8	12.2	10.8	9.5	10.8	1.6	1.3	1.9	1.7	2.1	1.6
Mendocino			8.6	37.7	33.5	15.7			1.3	5.0	5.3	4.4
Sacramento	7.5	8.8	33.8	34.6	28.1	19.6	2.1	1.6	4.5	3.4	4.1	3.5
San Diego	7.4	5.0	20.9	29.9	12.3	11.1	1.5	1.1	1.6	3.3	2.7	2.0
Santa Clara	5.9	5.3	17.0	18.5	19.3	13.2	1.7	1.4	2.2	2.4	3.1	2.3
Shasta	8.3	10.4	25.5	52.0	43.7	29.0	2.3	2.1	3.5	4.0	6.3	5.3
Sonoma	15.6	49.0	75.9	55.1	57.4	20.5	2.2	3.2	5.5	5.8	5.4	4.9

[a] A blank space indicates that no specific determination was made.

is coupled to a 2-inch pyrex 10-stage photomultiplier tube and mounted within a commercial lead pig.

The 3″ x 3″ sodium iodide crystal is also coupled to a pyrex 10-stage photomultiplier tube housed in a 2-inch lead pig, which is shielded by 4-inch lead bricks. The high voltage power supply is a battery pack for voltage stability and interference elimination.

The 4″ x 4″ sodium iodide crystal is optically coupled to a quartz 11-stage 3-inch photomultiplier tube. This crystal has a resolution of 9 percent for a cesium–137 source. The detector unit is housed in a 6-ton steel chamber which provides 6 inches of steel, ⅛ inch of lead, ⅛ inch of cadmium, and ¹⁄₁₆ inch of copper shielding. The layer of high-Z lead reduces backscatter from the steel, and the successively lower-Z cadmium and copper reduce, in turn, the 75-Kev lead flourescence X-rays. In whole milk samples, the counting efficiency for iodine–131 is 4.0 percent.

INDIANA MILK NETWORK
October–November 1962

Bureau of Environmental Sanitation
Indiana State Board of Health

In September 1961, the Indiana State Board of Health initiated a program of milk sampling for radiological analyses. Indiana was geographically divided into five major milksheds, and one large dairy within each milkshed was selected as a sampling station (see figure 6).

The milk samples are routinely analyzed for iodine–131, cesium–137, barium-lanthanum–140, strontium–89, and strontium–90. Analyses for iodine–131, cesium–137, and barium-lanthanum–140 are conducted on a weekly basis except when iodine–131 results exceed 100 μμc/liter, at which time the frequency of sampling is increased. Samples which are analyzed for strontium–90 are composited weekly and analyzed monthly.

The trichloroacetic acid analytical procedure (*1*) is used for strontium–89 and strontium–90 analyses. A 512-channel pulse height analyzer and shielded 4″ x 4″ sodium iodide crystal are used for the gamma scintillation analysis of iodine–131, cesium–137, and barium-lanthanum–140.

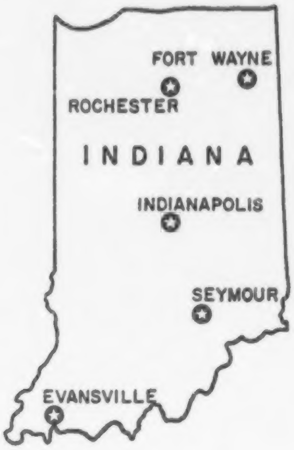

FIGURE 6.—INDIANA MILK SAMPLING LOCATIONS

The monthly averages of the data obtained for the individual sampling stations and the State averages are reported in table 4. The State average is an arithmetic average of the station values.

REFERENCE

(*1*) Robert A. Taft Sanitary Engineering Center, Public Health Service: *Radionuclide Analysis of Environmental Samples, Technical Report, R59-6* (1959).

TABLE 4.—INDIANA MILK NETWORK, OCTOBER–NOVEMBER 1962

[Concentrations in μμc/liter]

Sampling location	Strontium–89		Strontium–90		Iodine–131		Cesium–137		Barium–140	
	October	November	October	November	October	November	October	November	October	November
Evansville	95	[a]	14	[a]	80	110	35	40	10	10
Fort Wayne	60	[a]	19	[a]	70	40	45	50	<10	<10
Indianapolis	80	[a]	5	[a]	40	100	40	45	10	<10
Rochester	85	[a]	13	[a]	70	60	50	50	<10	<10
Seymour	100	[a]	4	[a]	40	80	40	50	<10	<10
State average	85	[a]	11	[a]	60	80	40	45	<10	<10

[a] Available next month.

RADIONUCLIDES IN CANADIAN MILK
Third Quarter 1962

*Radiation Protection Division,
Department of National Health and Welfare,
Ottawa, Canada*

Both dried milk products (skim milk and buttermilk powder) and liquid whole milk are currently being sampled by the Department of National Health and Welfare.

Dried Milk Products

Samples are collected through the cooperation of the Marketing Division of the Canadian Department of Agriculture, whose dairy products inspectors pick up four 1-pound samples of dried milk from each station (see figure 7) on a monthly schedule.

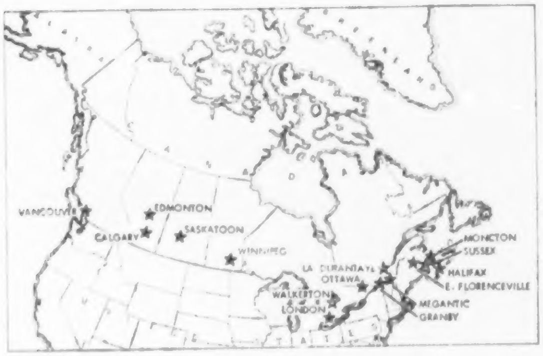

FIGURE 7.—CANADIAN DRIED MILK SAMPLING STATIONS

No statistical plan is followed for sample collection. Because of uncertainties introduced by this method of sampling, the significance of differences between station-to-station and month-to-month results is not precisely known. However, it is possible to consider all results for a given period of time as being sufficiently random in selection to show any national trend when average values for such periods and all stations are plotted, as in figures 8, 9 and 10. It should be emphasized that average concentrations over a considerable period of time are more meaningful from the public health point of view than fluctuating monthly concentrations.

A detailed discussion of the sampling and

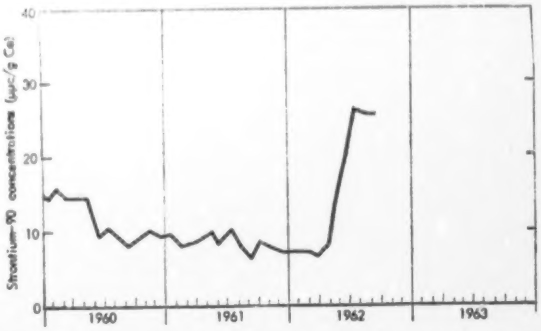

FIGURE 8.—AVERAGE STRONTIUM-90 CONCENTRATIONS IN CANADIAN DRIED MILK POWDER

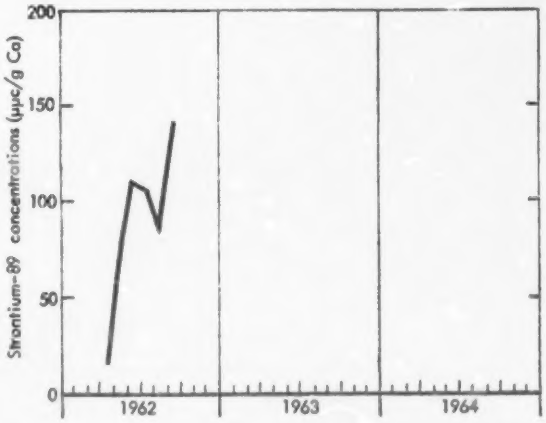

FIGURE 9.—AVERAGE STRONTIUM-89 CONCENTRATIONS IN CANADIAN DRIED MILK POWDER

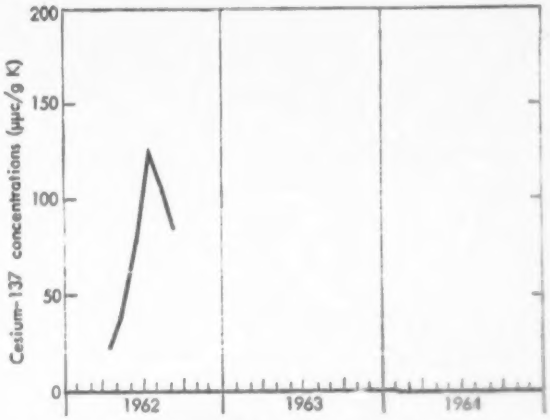

FIGURE 10.—AVERAGE CESIUM-137 CONCENTRATIONS IN CANADIAN DRIED MILK POWDER

Table 5.—RADIONUCLIDES IN CANADIAN DRIED MILK POWDER, 1962

Station	Strontium-89 μμc/g Ca			Strontium-90 μμc/g Ca			Cesium-137 μμc/g K		
	July	Aug.	Sep.	July	Aug.	Sep.	July	Aug.	Sep.
Arborg [a]	90.3	106.1	116.7	20.5	41.6	20.8	88.9	75.6	69.6
Calgary [a]	165.0	47.1	287.0	34.5	16.2	39.3	128.8	129.8	102.3
E. Florenceville [a]	126.0	97.0	178.6	27.3	31.2	34.5	107.1	111.3	124.3
Edmonton	136.2	83.0	389.4	24.7	25.0	42.3	93.3	71.6	107.0
Grunthal	74.4	95.4	119.9	19.3	28.4	19.7	[b] —	85.6	79.5
Halifax	104.2	171.5	163.3	32.9	29.9	27.7	161.1	135.2	95.1
La Durantaye	107.6	80.9	115.9	26.0	35.8	21.7	135.6	121.2	68.6
Lawrenceville	99.7	106.8	95.8	32.9	42.1	28.3	160.6	168.2	82.4
London	63.8	45.2	57.3	11.4	11.7	21.7	77.4	53.0	34.8
Megantic	85.0	113.4	141.7	29.2	31.3	34.7	183.7	212.6	113.6
Moncton	236.9	126.3	108.1	51.8	31.5	21.4	189.5	131.5	85.7
Nicolet	116.3	62.9	104.4	29.0	18.7	21.1	—	69.5	67.7
Ottawa	54.1	47.3	45.7	12.8	13.9	13.0	57.1	65.0	57.8
Saskatoon [a]	61.8	47.9	170.5	12.6	13.3	22.1	—	59.8	58.8
Sussex	176.5	99.5	136.2	44.7	36.7	36.1	141.2	119.3	104.7
Vancouver	105.7	46.3	108.6	27.6	23.5	21.1	155.2	130.9	112.8
Walkerton	75.8	49.1	72.1	14.1	11.6	15.9	71.0	70.0	59.8
Average	110.5	83.9	141.8	26.5	26.0	25.9	125.0	106.5	83.8

[a] Buttermilk—all other samples were skim milk powders.
[b] Dash indicates no sample.

radiochemical procedures employed may be found in the Department's publication (*1*). Table 5 presents the results of measurements of strontium-89, strontium-90 and cesium-137 in Canadian dried milk powder for the third quarter of 1962. These data were taken from the "Monthly Report, Radioactive Fallout in Canada," dated October-November 1962, published by the Radiation Protection Division of the Department of National Health and Welfare.

The average strontium-90 concentrations in milk remained approximately constant at about 26 μμc/g calcium during the third quarter of 1962. The Canadian average for the twelve-month period from October 1961 through September 1962 was 13.9 μμc Sr^{90}/g calcium, and the record high of 26.5 μμc Sr^{90}/g calcium occurred in July 1962.

The average strontium-89 concentration in milk increased markedly during the second quarter 1962, and have fluctuated during the third quarter.

For an approximate method to compare the Canadian powdered milk data in units of μμc/g calcium to other milk data in units of μμc/liter, it can be assumed that milk has approximately 1.2 g calcium/liter of liquid milk. Canadian powdered milk data may be compared to liquid milk data by multiplying the former values by 1.2.

The average cesium-137 concentrations in dried milk rose from 20.3 μμc/g potassium in April to 125.0 μμc/g potassium in July and then declined to 83.8 μμc/g potassium in September.*

Whole Milk

Recently, monitoring of liquid whole milk for iodine-131 was begun. The presence of iodine-131 in milk is closely dependent on the continuance of nuclear testing programs because of the short half-life (8 days) of iodine-131. Iodine levels will decrease quickly in the absence of such testing. Iodine-131 levels in milk are also expected to fall rapidly when dairy cows are taken off pasture for the winter.

Table 6 presents the average monthly concentration of iodine-131 in liquid whole milk for seven cities for May through September 1962. The average rose sharply from 8.4 μμc/liter in August to 138 μμc/liter in September.

Table 6.—IODINE-131 IN CANADIAN LIQUID WHOLE MILK, 1962

[Concentrations in μμc/liter]

Station	May	June	July	August	September
Calgary	—	—	13.4	10.8	372
Halifax	13.0	6.9	7.3	8.0	44
London	—	—	14.1	6.6	110
Ottawa	6.6	5.0	9.3	4.9	76
Sault St. Marie	—	—	—	10.6	172
Winnipeg	—	—	5.8	6.7	140
Vancouver	5.9	6.1	3.9	10.9	50
Average	8.5	6.0	9.0	8.4	138

It should be emphasized again that the interpretation of fallout data in relation to health is a complex problem. In comparing the values of the concentration levels in a particular medium with the so-called Maximum Permissible Concentrations (MPC), as established by the International Commission on Radiological Protection (*2*), it is necessary to keep in mind that the MPC values refer to conditions of continuous exposure over a lifetime. Therefore, the average levels over an extended period, such as one year, represent a better basis for comparison than do individual levels at any specific time.

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* April data taken from January 1963 *Radiological Health Data.*

Previous coverage in *Radiological Health Data:*

Period	Issue
Third quarter 1961	*May 1962*
Fourth quarter 1961	*September 1962*
First quarter 1962	*October 1962*
Second quarter 1962	*January 1963*

REFERENCES

(*1*) Radiation Protection Division, Department of National Health and Welfare, Ottawa, Canada: *The Preliminary Report on the Measurements of Radioactive Strontium in Canadian Milk Powder Samples, CNHW (RP–1)* (July 1958).

(*2*) Recommendations of the International Commission on Radiological Protection: *Report of Committee II on Permissible Dose for Internal Radiation, Pergamon Press, New York,* (1959).

Twelve-Month Sum of Daily Radionuclide Content of One Liter of Pasteurized Milk

December 1961–November 1962: Iodine–131
November 1961–October 1962: Strontium–89 and Strontium–90

Division of Radiological Health, Public Health Service

The guidance of the Federal Radiation Council is given in terms of ranges of transient rates of intake of radioactive materials in micromicrocuries per day. These ranges are based on radiation doses considered acceptable for lifetime exposure from normal peacetime atomic industry operations. The Council recommends the use of a time period of one year as an appropriate interval for averaging exposures and has recently emphasized that the annual acceptable exposure dose is not a "danger point" which, if exceeded, requires protective measures (*1, 2, 3*).

Tables 1 and 2 below furnish a means towards estimating the contribution of milk to the total dietary intake of iodine–131, strontium–89, and strontium–90 and facilitate comparison of the concentrations of certain radionuclides in milk with the FRC's Radiation Protection Guides. The tables are based on the same data which are used for computing the Pasteurized Milk Network monthly averages. They present index values which are the estimated sum of the daily amounts of a radionuclide in one liter of milk for a 12-month period.

The tables show 12-month index values for each of the Network's 62 sampling locations. Due to the longer time required for strontium–89 and strontium–90 analysis, these 12-month index values are for the year beginning one month earlier than the year for the iodine–131 values. The columns of monthly index values in each table are used to compute the net change as the yearly index values are advanced by one month. The following column shows this new 12-month index value. In addition, the first column in table 1 gives the iodine–131 November concentration averages.

The data in tables 1 and 2 are calculated as follows: (a) results from all samples collected in each week (Sunday through Saturday) are averaged, (b) the weekly averages for all weeks ending within a given month are averaged and an average for the month is obtained, and (c) the monthly radionuclide index value is determined by multiplying the average for the month by the number of days in the month. The number of days in the month will be either 28 or 35, corresponding to the complete calendar weeks used for any month. Procedures exemplified by (a) and (b) above minimize the effect of any one day's sample results on the average for the month, particularly for a short-lived radionuclide such as iodine–131.

For a number of reasons it is desirable to have a standard quantity of milk to use in the

TABLE 1.—TWELVE-MONTH SUM OF DAILY AMOUNTS OF IODINE-131 IN ONE LITER OF MILK

Sampling locations		Nov 1962 Iodine-131 averages ($\mu\mu c$/liter)	Iodine-131 index values ($\mu\mu c$ day/liter)[a]			
			Nov 1961–Oct 1962	Nov 1961	Oct 28, 1962–Nov 24, 1962	Dec 1961–Nov 1962
Ala:	Montgomery	70	3,800	900	1,960	4,860
Alaska:	Palmer	40	36,990	1,200	1,120	36,910
Ariz:	Phoenix	30	5,430	2,400	840	3,870
Ark:	Little Rock	100	9,640	4,500	2,800	7,940
Calif:	Sacramento	20	4,300	900	560	3,960
	San Francisco	10	4,350	600	280	4,030
Colo:	Denver	20	6,340	1,200	560	5,700
Conn:	Hartford	50	6,980	900	1,400	7,480
Del:	Wilmington	140	8,370	1,800	3,920	10,490
D.C:	Washington	80	6,360	900	2,240	7,700
Fla:	Tampa	80	3,650	1,200	2,240	4,690
Ga:	Atlanta	80	5,220	1,200	2,240	6,260
Hawaii	Honolulu	20	3,710	600	560	3,670
Idaho	Idaho Falls	50	10,450	3,000	1,400	8,850
Ill:	Chicago	60	13,570	2,100	1,680	13,150
Ind:	Indianapolis	90	9,710	1,800	2,520	10,430
Iowa:	Des Moines	120	22,620	6,300	3,360	19,680
Kans:	Wichita	80	21,540	4,200	2,240	19,580
Ky:	Louisville	130	7,820	2,400	3,640	9,060
La:	New Orleans	60	5,680	1,800	1,680	5,560
Maine:	Portland	70	6,770	900	1,960	7,830
Md:	Baltimore	80	6,610	900	2,240	7,950
Mass:	Boston	40	7,990	1,200	1,120	7,910
Mich:	Detroit	80	12,600	2,700	2,240	12,140
	Grand Rapids	50	9,140	1,800	1,400	8,740
Minn:	Minneapolis	80	17,620	4,500	2,240	15,360
Miss:	Jackson	80	6,020	1,800	2,240	6,460
Mo:	Kansas City	140	28,840	5,700	3,920	27,060
	St. Louis	80	12,130	3,000	2,240	11,370
Mont:	Helena	70	13,300	3,300	1,960	11,960
Nebr:	Omaha	80	17,510	3,600	2,240	16,150
Nev:	Las Vegas[b]	10	3,500	[c]—	280	3,780
N.H:	Manchester	40	7,180	1,200	1,120	7,100
N.J:	Trenton	90	5,830	900	2,520	7,450
N. Mex:	Albuquerque	20	6,850	1,200	560	6,210
N.Y:	Buffalo	20	8,570	600	560	8,530
	New York	80	10,080	1,200	2,240	11,120
	Syracuse	40	9,570	900	1,120	9,790
N.C:	Charlotte	30	2,590	600	840	2,830
N.D:	Minot	60	13,500	600	1,680	14,580
Ohio:	Cincinnati	140	11,320	2,400	3,920	12,840
	Cleveland	80	9,120	1,500	2,240	9,860
Okla:	Oklahoma City	100	15,180	4,800	2,800	13,180
Ore:	Portland	80	11,050	5,100	2,240	8,190
Pa:	Philadelphia	130	7,350	1,200	3,640	9,790
	Pittsburgh	170	9,220	900	4,760	13,080
P.R:	San Juan	[d]	3,990	600	—	3,390
R.I:	Providence	80	7,160	1,500	2,240	7,900
S.C:	Charleston	40	3,510	600	1,120	4,030
S.D:	Rapid City[e]	90	10,190	—	2,520	12,710
Tenn:	Chattanooga	90	5,010	1,200	2,520	6,330
	Memphis	100	6,970	2,400	2,800	7,370
Tex:	Austin	60	4,080	1,800	1,680	3,960
	Dallas	80	7,240	3,000	2,240	6,480
Utah:	Salt Lake City	30	32,200	1,800	840	31,240
Vt:	Burlington	70	7,900	1,500	1,960	8,360
Va:	Norfolk	60	4,540	900	1,680	5,320
Wash:	Seattle	90	9,990	3,600	2,520	8,910
	Spokane	40	21,490	1,800	1,120	20,810
W. Va:	Charleston	70	4,930	600	1,960	6,290
Wis:	Milwaukee	100	13,380	2,400	2,800	13,780
Wyo:	Laramie	10	20,590	900	280	19,970

[a] The data in this table are index values, not to be interpreted as consumption or total intake values. Annual I^{131} intake per person from milk may be calculated from an index value in this table by applying the appropriate factor representing average individual daily milk consumption for any selected group under consideration.

Example: 12-month I^{131} index ($\mu\mu c$ day/liter) × milk consumption factor (liter/day/person) = 12-month I^{131} intake ($\mu\mu c$/person)

[b] Station began operation in July 1962.

[c] Dash indicates no data available.

[d] No sample was received for November 1962.

[e] Station began operation in January 1962.

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TABLE 2.—TWELVE-MONTH SUM OF DAILY AMOUNTS OF STRONTIUM-89 AND STRONTIUM-90 IN ONE LITER OF MILK

Sampling locations		Strontium-89 index values ($\mu\mu c$ day/liter)[a]				Strontium-90 index values ($\mu\mu c$ day/liter)[a]			
		Oct 1961–Sep 1962	Oct 1961	Sep 30, 1962–Oct 27, 1962	Nov 1961–Oct 1962	Oct 1961–Sep 1962	Oct 1961	Sep 30, 1962–Oct 27, 1962	Nov 1961–Oct 1962
Ala:	Montgomery	18,765	465	560	18,860	4,507	217	364	4,654
Alaska:	Palmer	16,900	3,255	4,200	17,845	3,513	496	448	3,465
Ariz:	Phoenix	5,190	80	1,400	6,510	1,242	93	196	1,345
Ark:	Little Rock	43,145	1,085	1,960	44,020	9,355	465	784	9,674
Calif:	Sacramento	6,015	310	420	6,125	1,460	248	112	1,324
	San Francisco	10,520	80	140	10,580	1,829	93	56	1,792
Colo:	Denver	10,640	465	560	10,735	3,109	186	364	3,287
Conn:	Hartford	6,940	930	1,400	7,410	3,655	310	336	3,681
Del:	Wilmington	13,140	1,395	1,400	13,145	4,409	465	392	4,336
D.C:	Washington	12,080	1,085	1,400	12,395	4,357	248	504	4,613
Fla:	Tampa	7,855	465	560	7,950	3,101	155	252	3,198
Ga:	Atlanta	27,815	620	840	28,035	5,926	372	504	6,058
Hawaii:	Honolulu	9,120	80	420	9,460	1,809	124	224	1,909
Idaho:	Idaho Falls	8,955	1,085	840	8,710	2,594	248	364	2,710
Ill:	Chicago	11,540	1,705	1,680	11,515	3,491	279	392	3,604
Ind:	Indianapolis	12,635	930	1,820	13,525	4,435	217	392	4,610
Iowa:	Des Moines	22,810	2,015	2,940	23,735	4,258	465	448	4,241
Kans:	Wichita	16,910	930	1,680	17,660	3,790	341	364	3,813
Ky:	Louisville	23,075	465	1,820	24,430	5,910	341	672	6,241
La:	New Orleans	65,530	1,240	1,260	65,550	10,054	465	672	10,261
Maine:	Portland	11,955	3,720	2,100	10,335	4,484	341	532	4,675
Md:	Baltimore	11,165	930	1,400	11,635	4,535	248	504	4,791
Mass:	Boston	12,785	3,720	2,800	11,865	5,029	372	560	5,217
Mich:	Detroit	9,585	1,550	1,960	9,995	3,204	217	448	3,435
	Grand Rapids	10,935	2,325	1,260	9,870	3,161	217	308	3,252
Minn:	Minneapolis	24,030	5,270	3,360	22,120	4,862	527	728	5,063
Miss:	Jackson	55,910	1,240	1,120	55,790	8,323	372	588	8,539
Mo:	Kansas City	28,390	2,635	2,800	28,555	4,503	217	476	4,762
	St. Louis	17,355	930	1,540	17,965	4,427	310	448	4,565
Mont:	Helena	13,510	465	1,540	14,585	3,428	403	532	3,557
Nebr:	Omaha	24,255	3,875	1,960	22,340	4,156	465	364	4,055
Nev:	Las Vegas[b]	2,345	[c]—	700	3,045	427	—	224	651
N.H:	Manchester	9,385	1,240	2,240	10,385	4,501	372	644	4,773
N.J:	Trenton	8,885	1,240	1,820	9,465	3,658	248	392	3,802
N. Mex:	Albuquerque	4,675	80	420	5,015	1,645	310	168	1,503
N.Y:	Buffalo	8,795	1,395	1,820	9,220	3,740	341	392	3,791
	New York	9,440	1,550	2,380	10,270	4,241	248	644	4,637
	Syracuse	10,370	2,790	2,100	9,680	3,366	248	532	3,650
N.C:	Charlotte	18,445	930	1,400	18,915	6,122	279	588	6,431
N. Dak:	Minot	16,680	1,690	2,660	17,650	5,211	372	644	5,483
Ohio:	Cincinnati	16,690	775	1,400	17,315	4,487	186	476	4,777
	Cleveland	9,625	1,240	1,820	10,205	3,646	217	420	3,849
Okla:	Oklahoma City	24,850	930	1,120	25,040	5,113	186	476	5,403
Ore:	Portland	21,950	80	3,080	24,950	4,727	372	560	4,915
Pa:	Philadelphia	9,110	1,085	1,260	9,285	4,004	217	420	4,207
	Pittsburgh	10,845	2,015	1,680	10,510	4,741	279	644	5,106
P.R:	San Juan	23,900	310	560	24,150	3,200	217	196	3,179
R.I:	Providence	10,260	1,860	1,680	10,080	3,929	310	532	4,151
S.C:	Charleston	21,200	465	980	21,715	6,034	341	532	6,225
S. Dak:	Rapid City[d]	15,480	—	1,680	17,160	4,082	—	392	4,474
Tenn:	Chattanooga	38,255	775	1,260	38,740	7,107	310	560	7,357
	Memphis	35,930	930	1,680	36,680	6,748	217	532	7,063
Tex:	Austin	9,555	310	280	9,525	2,218	124	196	2,290
	Dallas	22,920	620	700	23,000	4,596	248	476	4,824
Utah:	Salt Lake City	10,080	775	840	10,145	2,692	217	280	2,755
Vt:	Burlington	9,575	1,550	2,520	10,545	3,702	248	392	3,846
Va:	Norfolk	18,560	2,635	1,120	17,045	5,472	248	560	5,784
Wash:	Seattle	18,235	2,325	2,940	18,850	4,792	465	812	5,139
	Spokane	10,555	310	1,120	11,365	3,629	186	420	3,863
W. Va:	Charleston	20,530	2,170	1,820	20,180	5,555	248	762	5,979
Wis:	Milwaukee	7,670	1,240	1,680	8,110	2,713	279	336	2,770
Wyo:	Laramie	14,850	80	1,680	16,450	3,011	248	364	3,127

[a] The data in this table are index values, not to be interpreted as consumption or total intake values. Annual strontium-89 and strontium-90 intake per person from milk may be calculated from an index value in this table by applying the appropriate factor representing average individual daily milk consumption for any selected group under consideration.

Example: 12-month Sr^{89} or Sr^{90} index × milk consumption factor = 12-month Sr^{89} or Sr^{90} intake
($\mu\mu c$ day/liter) (liter/day/person) ($\mu\mu c$/person)

[b] Station began operation in July 1962.

[c] Dash indicates no data are available.

[d] Station began operation in January 1962.

development of index values for the different radionuclides. In the case of strontium, 1 liter is a suitable quantity as this amount of milk supplies approximately 1 gram of calcium, the amount used by the Federal Radiation Council in deriving the intake guidance for strontium. In the case of iodine–131, the critical age group is the young infant. Available information suggests that the average milk consumption of infants in the 6–18 month group is not more than 1 liter per day. Thus the index value based on 1 liter of milk, though not directly an average intake value, is probably the most useful index for estimating total intake.

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SECTION IV.—WATER

Radioactivity in Raw Surface Waters

NATIONAL WATER QUALITY NETWORK
August 1962

Division of Water Supply and Pollution Control, Public Health Service

The National Water Quality Network was initiated in October 1957. (*1*). This network, operated by the Public Health Service in cooperation with State and local agencies, consisted of 123 stations as of the end of August (figure 1).

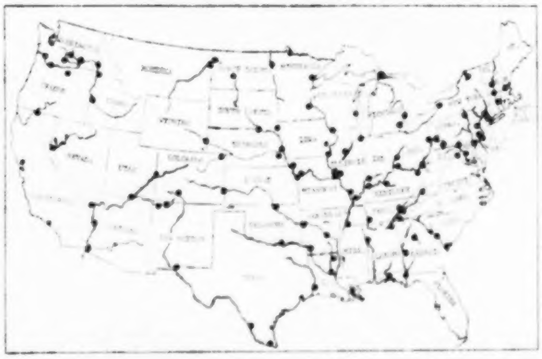

FIGURE 1.—NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS, AUGUST 1962

These stations are located on the major waterways used for public water supplies, propagation of fish and wildlife, and recreational, agricultural, and industrial purposes. Samples are taken weekly, monthly, or continuously, depending on the type of analysis and the water quality. These samples are analyzed for plankton population, organic chemicals, chemical, biological, and physical quality, and radioactivity (*2*, *3*).

The radioactivity associated with dissolved solids provides a rough measure of the levels which may be found in treated water, since nearly all of the suspended matter is removed by treatment processes (*4*). It has been observed that in water the natural environmental beta activity is usually several times that of the natural environmental alpha activity. Nuclear installations may contribute additional alpha or beta activity whereas fallout contributes primarily additional beta activity. Gross alpha and beta measurements are made on both suspended and dissolved solids (strontium-90 on the total solids only) in raw surface water samples according to established procedures (*5*, *6*). Because strontium-90 analyses are done quarterly, the results will be published on this basis.

For the first two years, beta determinations were made on weekly samples, and alpha determinations were generally made on composites of more than one weekly sample. From January 1960 to September 1961, alpha and

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS, AUGUST 1962

[Average concentrations in pc/liter]

Station	August 1962					
	Beta activity			Alpha activity		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Allegheny River: Pittsburgh, Pa	6	19	25	0	0	0
Animas River: Cedar Hill, N. Mex	9	26	35	1	5	6
Apalachicola River: Chattahoochie, Fla	2	8	10	0	0	0
Arkansas River:						
Coolidge, Kans	54	124	178	6	17	23
Ponca City, Okla	115	37	152	19	1	20
Pendleton Ferry, Ark	—	—	—	—	—	—
Bear River: Preston, Idaho	6	29	35	0	1	1
Bighorn River: Hardin, Mont	322	54	376	50	6	56
Big Sioux River: Sioux Falls, S. Dak	17	48	65	1	4	5
Chattahoochie River:						
Atlanta, Ga	7	6	13	1	0	1
Columbus, Ga	5	9	14	—	—	—
Lanett, Ala	7	10	17	1	0	1
Chena Slough: Fairbanks, Alaska	5	11	16	0	<1	<1
Clear Water River: East Lewiston, Idaho	7	5	12	0	0	0
Clinch River: Kingston, Tenn	136	58	195	5	<1	5
Colorado River:						
Loma, Colo	17	29	46	2	8	10
Page, Ariz	206	26	232	43	6	49
Boulder City, Nev	22	37	59	0	5	5
Parker Dam, Calif.-Ariz	13	21	34	1	10	11
Yuma, Ariz	39	86	119	1	0	1
Columbia River:						
Northport, Wash	5	10	15	0	1	1
Wenatchee, Wash	5	15	20	0	0	0
Pasco, Wash	37	336	373	0	0	0
McNary Dam, Ore	26	180	206	0	0	0
Bonneville, Ore	—	—	—	—	—	—
Clatskanie, Ore	19	129	148	0	0	0
Connecticut River:						
Wilder, Vt	7	16	23	0	0	0
Northfield, Mass	4	13	17	—	—	—
Enfield Dam, Conn	7	11	18	0	0	0
Cumberland River: Clarksville, Tenn	—	—	—	—	—	—
Delaware River:						
Martins Creek, Pa	2	8	10	0	0	0
Trenton, N.J	2	9	11	0	<1	<1
Philadelphia, Pa	9	13	22	—	—	—
Escambia River: Century, Fla	15	12	27	0	0	0
Great Lakes:						
Duluth, Minn	6	6	12	0	0	0
Sault Ste. Marie, Mich	2	10	12	—	—	—
Milwaukee, Wis	3	11	14	0	0	0
Gary, Ind	4	10	14	0	0	0
Port Huron, Mich	4	11	15	—	—	—
Detroit, Mich	2	6	8	0	1	1
Buffalo, N Y	24	10	34	0	0	0
Green River: Dutch John, Utah	10	23	33	1	2	3
Hudson River: Poughkeepsie, N.Y	3	10	13	0	0	0
Illinois River:						
Peoria, Ill	8	26	34	0	0	0
Grafton, Ill	6	30	36	1	1	2
Kanawha River: Winfield Dam, W. Va	9	10	19	—	—	—
Klamath River: Keno, Ore	5	11	16	0	0	0
Little Miami River: Cincinnati, Ohio	6	14	20	—	—	—
Mississippi River:						
St. Paul, Minn	20	28	48	0	2	2
Dubuque, Iowa	—	—	—	—	—	—
Burlington, Iowa	6	22	28	0	0	0
E. St. Louis, Ill	6	28	31	—	—	—
Cape Girardeau, Mo	46	32	78	3	2	5
W. Memphis, Ark	26	24	50	0	1	1
Delta, La	43	30	73	21	2	23
New Orleans, La	8	22	30	0	1	1
Vicksburg, Miss	33	29	62	4	1	5
Missouri River:						
Williston, N. Dak	73	31	104	—	—	—
Bismarck, N. Dak	14	24	38	<1	3	3
Yankton, S. Dak	34	45	79	0	3	3
Omaha, Nebr	55	41	96	4	6	10
St. Joseph, Mo	69	60	129	—	—	—
Kansas City, Kans	55	41	96	4	4	8
St. Louis, Mo	146	39	185	6	8	14
Missouri City, Mo	53	31	84	1	4	5
Monongahela River: Pittsburgh, Pa	1	22	23	—	—	—
North Platte River: Henry, Nebr	25	46	71	1	9	10
Ohio River:						
Addison, Ohio	12	8	20	0	0	0
Huntington, W. Va	1	9	10	0	0	0
Cincinnati, Ohio	2	18	20	0	0	0
Louisville, Ky	5	15	20	0	0	0
Evansville, Ind	11	22	33	0	0	0
Cairo, Ill	8	15	23	0	0	0
Ouachita River: Bastrop, La	5	12	16	1	1	2
Pend Oreille River: Albeni Falls Dam, Idaho	2	9	11	0	0	0
Platte River: Plattsmouth, Nebr	118	57	175	7	2	9

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TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS, AUGUST 1962—Continued

[Average concentrations in pc/liter]

Station	August 1962					
	Beta activity			Alpha activity		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Potomac River:						
Williamsport, Md	1	10	11	—	—	—
Great Falls, Md	1	16	17	1	0	1
Rainy River:						
Baudette, Minn	12	38	50	0	0	0
International Fls., Minn	7	30	37	0	0	0
Raritan River: Perth Amboy, N.J	36	129	165	3	0	3
Red River, North: Grand Forks, N. Dak	—	—	—	—	—	—
Red River, South:						
Denison, Tex	30	108	138	1	3	4
Index, Ark	4	10	14	0	1	1
Bossier City, La	23	74	97	1	1	2
Alexandria, La	7	67	74	1	1	2
Rio Grande River:						
Alamosa, Colo	1	11	12	0	4	4
El Paso, Tex	46	22	68	2	3	5
Laredo, Tex	35	25	60	1	6	7
Brownsville, Tex	16	52	68	0	2	2
Roanoke River: John H. Kerr Resr. & Dam, Va	5	7	12	1	0	1
Sabine River: Ruliff, Tex	7	14	21	0	1	1
Sacramento River: Greens Landing Courtland, Calif	3	9	12	0	0	0
San Joaquin River: Vernalis, Calif	9	27	36	<1	6	6
San Juan River: Shiprock, N. Mex	5	73	78	0	19	19
St Lawrence River: Massena, N.Y	5	7	12	0	0	0
Schuykill River: Philadelphia, Pa	4	23	27	0	0	0
Savannah River:						
North Augusta, S.C	6	5	11	0	0	0
Port Wentworth, Ga	7	90	97	0	0	0
Shenandoah River: Berryville, Va	17	12	29	1	1	2
Ship Creek: Anchorage, Alaska	3	6	9	0	0	0
Snake River:						
Ice Harbor Dam, Wash	2	10	12	0	1	1
Wawawai, Wash	3	17	20	0	2	2
Payette, Idaho	8	15	23	1	3	4
South Platte River: Julesburg, Colo	43	88	131	4	21	25
Spokane River: Post Falls, Idaho	3	8	11	0	0	0
Susquehanna River:						
Sayre, Pa	5	16	21	0	0	0
Conowingo, Md	3	12	15	0	0	0
Tennessee River:						
Chattanooga, Tenn	3	31	34	0	0	0
Bridgeport, Ala	5	40	45	0	0	0
Pickwick Landing, Tenn	9	15	24	1	0	1
Lenoir City, Tenn	3	9	12	0	0	0
Tombigbee River: Columbus, Miss	8	9	17	1	0	1
Truckee River: Farad, Calif	1	4	5	0	1	1
Verdigris River: Nowata, Okla	4	34	38	<1	<1	1
Wabash River: New Harmony, Ind	45	19	64	3	<1	3
Willamette River: Portland, Ore	2	2	4	0	0	0
Yakima River: Richland, Wash	4	12	16	0	1	1
Yellowstone River: Sidney, Mont	165	31	196	5	4	9

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beta determinations were generally made once a month on weekly composited samples. Beginning in September 1961, alpha determinations have been made on one sample each month, and beta determinations have generally been made on weekly samples. For the first operating year of each new station, sampling, and alpha and beta analysis are done weekly.

If at any time activity significantly greater than the normal environmental levels has been noted, the rate of sampling and analysis has been increased to at least one every week. Since January 1959, a portion of each sample from all stations in the network has been composited into a three-month station sample for measurement of strontium-90 (*7*). Strontium-90 data will be presented quarterly.

Table 1 presents the results of the alpha and beta analyses on raw surface water in the United States for August 1962. Figure 2 shows the median of the quarterly averages of each station of beta activity found in suspended plus dissolved solids of raw surface water for the years 1958 through 1961.

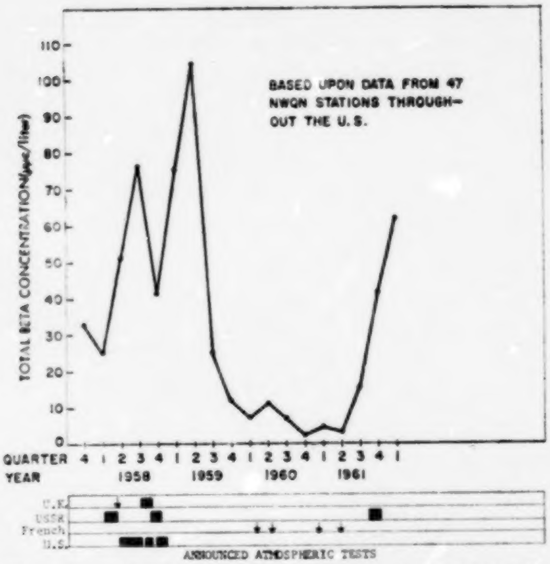

FIGURE 2.—MEDIAN TOTAL BETA RADIOACTIVITY IN U.S. RAW SURFACE WATER

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North Carolina Cistern Water

June and August 1962

Sanitary Engineering Division
North Carolina State Board of Health

Investigations of radioactivity in North Carolina public surface water supplies have been underway since June 1958 (*1*). Originally, these studies were confined to surface water supplies, but during 1962 they were extended to include several small cistern water supplies utilized for drinking water on islands situated along the eastern seaboard.

The cistern supplies are characteristically constructed with roof pre-wash valves which permit the diversion of the first runoff and then allow the balance of the rainwater to pass into the cistern.

First available results from the cistern water sampling, begun in June 1962, have been received for ten cistern supplies on Ocracoke Island, which lies approximately 20 miles off the mainland (figure 3). Radioanalyses of the samples are performed at the State Laboratory in Raleigh. A one liter sample is collected and the total solids content is analyzed for gross radioactivity (alpha plus beta).

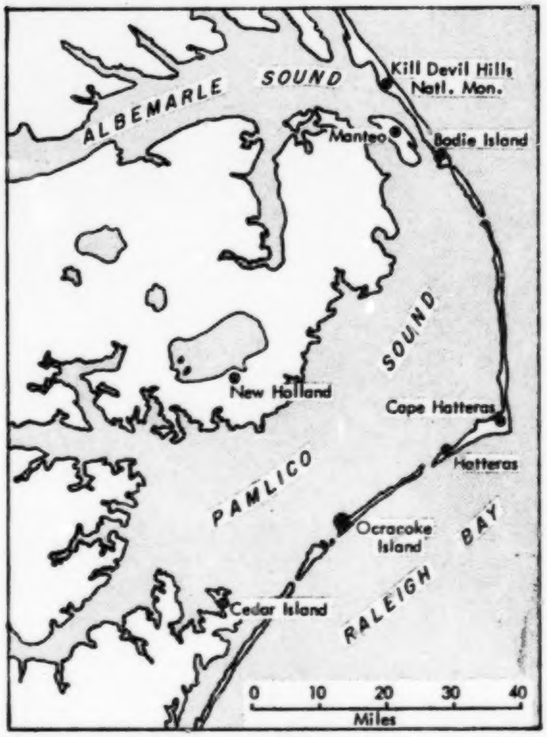
ALBEMARLE
SOUND
Kill Devil Hills
Natl. Mon.
Manteo
Bodie Island
SOUND
New Holland
Cape Hatteras
Hatteras
PAMLICO
Ocracoke Island
BAY
RALEIGH
Cedar Island
0
10
20
30
40
Miles

FIGURE 3.—EASTERN NORTH CAROLINA, SHOWING LOCATION OF OCRACOKE ISLAND

TABLE 2.—GROSS RADIOACTIVITY IN CISTERN WATER AT OCRACOKE ISLAND, NORTH CAROLINA

[μμc/liter]

Type of supply	June 20, 1962	August 29, 1962
Private residence	96	[a]—
Private residence	105	33
Private residence	71	—
Private residence	63	—
Public school	57	25
Public school	83	—
Hotel	75	—
Hotel	98	—
Public park	88	35
Coast Guard Station	190	61

[a] No sample

While the concentrations of strontium–90 and alpha emitters are not reported, some comparison may be drawn between the values shown in table 2 and drinking water standards for interstate carriers (*2*). These standards state that in the absence of strontium–90 and alpha emitters, a water supply is acceptable when the gross beta activity does not exceed 1000 μμc/liter.

REFERENCES

(*1*) Sanitary Engineering Division, North Carolina State Board of Health: *Background Radioactivity in Surface Water Supplies of North Carolina, 1958–1961.*

(*2*) Federal Register Rules and Regulations: *Title 42–Public Health Chapter 1–Public Health Service, Department of Health, Education, and Welfare; Part 72, Interstate Quarantine, Subpart J, Drinking Water Standards, 27*:2154–5, Superintendent of Documents, Government Printing Office, Washington 25, D.C. (March 6, 1962).

SECTION V.—OTHER DATA

Cesium–137 and Strontium–90 in Animal Feeds

1959–1962

Division of Pharmacology, Food and Drug Administration

Recognizing the importance of animal feeds in the food chain, the Food and Drug Administration (FDA) regularly samples and analyzes these products for cesium–137 and strontium–90, using the same procedures previously discussed for the FDA human food sampling program (*1*). The results of FDA determinations of the cesium–137 and strontium–90 contents of some selected animal feeds, arranged by year of harvest, are presented in table 1. It should be noted that the number of samples analyzed for cesium–137 is small, and that the number of samples analyzed for strontium–90 is small for some products.

From the table an approximate correlation between cesium–137 and strontium–90 is noted, in that the cesium–137 concentration is higher than the strontium–90 concentration in all samples.

Alfalfa

The cesium–137 data are too few for proper analysis, but the high values in 1962 are of interest. It can be observed that the strontium–90 content of alfalfa, however, decreased from 1959 to 1960, and then increased in 1961 and 1962. Samples harvested before resumption of nuclear weapons testing in September 1961 are from different parts of the country than those harvested after the resumption of nuclear weapons testing in late 1961 and in 1962; therefore, the 1961 and 1962 values cannot be directly compared with each other.

Beet Pulp

Some slight increase in strontium–90 content from 1960 to 1961 is noted.

Corn Silage

The limited cesium–137 values show a decrease from 1960 to 1961, while the strontium–90 values decreased from 1959 to 1961. The one value for 1962 is inconclusive.

Cottonseed

The cesium–137 values show very little in the way of a definite trend, although a difference in values may be noted. Cottonseed meal increased in strontium–90 content from 1959 to 1961, while the values for cottonseed hulls show little definite trend.

Lespedeza

The strontium–90 values show a decrease from 1959 through 1960 and into 1961, with an apparent increase from 1961 to 1962.

Peanut Hay

Little difference in strontium–90 values for 1960 through 1962 can be seen.

TABLE 1.—GEOGRAPHICAL DISTRIBUTION OF CESIUM-137 AND STRONTIUM-90 IN SELECTED ANIMAL FEEDS

Product	Cesium-137			Strontium-90		
	Number of samples	Average (pc/kg)	Range (pc/kg)	Number of samples	Average (pc/kg)	Range (pc/kg)
Alfalfa						
1959				22	378	23–1,470
1960				14	153	18– 425
1961	1	279		12	273	52– 779
1962	3	2,890	1,440–6,410	3	262	77– 365
Beet pulp						
1960				7	50	3.8– 127
1961				10	62	24– 112
Corn silage						
1959				17	90	19– 482
1960	3	759	2.7–2,000			
1961	2	649	556– 741	11	76	9– 513
1962				1	44	
Cottonseed hulls						
1960				2	42	36– 48
1961				1	30	
Cottonseed meal						
1959				1	4.6	
1960	3	215	34– 531	2	7.6	3.1– 12
1961	1	332		5	52	2.9– 95
Grass						
1959				1	510	
1960	1	194		1	145	
Hay						
1959				4	390	73– 732
1960	1	*ND				
1961				1	297	
Lespedeza						
1959				6	987	617–1,700
1960				8	479	45– 960
1961				3	393	204– 529
1962				2	658	417– 899
Peanut hay						
1960				7	740	507– 931
1961				3	726	520– 845
1962				1	639	
Sorghum						
1959				2	87	38– 49
1960				1	34	
1961	1	1900		3	198	35– 513

Table 1.—GEOGRAPHICAL DISTRIBUTION OF CESIUM-137 AND STRONTIUM-90 IN SELECTED ANIMAL FEEDS—Continued

Product	Cesium-137			Strontium-90		
	Number of samples	Average (pc/kg)	Range (pc/kg)	Number of samples	Average (pc/kg)	Range (pc/kg)
Soybean						
1959				1	27	
1960	1	ND		1	17	
1961				2	41	25– 57
1962 (meal)	1	500				
Timothy hay						
1959				4	413	355–1170

[a] N.D. indicates cesium-137 not detectable.

Sorghum

An apparent increase from 1959 and 1960 is seen in the 1962 strontium-90 values. Of interest is the single high cesium-137 value for 1962.

Summary

Limited cesium-137 concentrations in animal feeds are presented, together with more extensive values for strontium-90 concentrations. The cesium-137 values are higher than the strontium-90 values in all cases. The hays and leafy animal feeds continue to show increased radionuclide content over animal fodders.

Previous coverage in *Radiological Health Data:*

Period	Issue
1960	*December 1961*

REFERENCE

(*1*) Food and Drug Administration: Survey of Radioactivity in Food, *Radiological Health Data, 3*:476–81 (December 1962).

Air and Water Monitoring Near the Project Chariot Site
January–August 1962

Atomic Energy Commission

In May 1959 the U.S. Atomic Energy Commission approved a program of environmental studies to be conducted in conjunction with a proposed excavation project using nuclear explosives (Project Chariot, Plowshare Program) at the mouth of Ogotoruk Creek near Cape Thompson, Alaska. To date, no nuclear detonations have been scheduled for the project. In August 1962, the Commission decided to defer a recommendation that the President authorize performance of the experiment.

The proposed project would involve the simultaneous detonation of five nuclear devices. Four 20-kiloton devices would be buried to about 400 feet and one 200-kiloton device buried to about 800 feet. The detonation of the four smaller devices would be expected to produce a channel about 900 feet wide and 2,000 feet long, with a basin about 1800 feet in diameter resulting from explosion of the larger device. It is expected that about 95 percent of the fission products will be entrapped underground.

After the U.S.S.R. resumed testing on September 1, 1961, four fallout monitoring stations were activated at Cape Thompson, Kivalina,

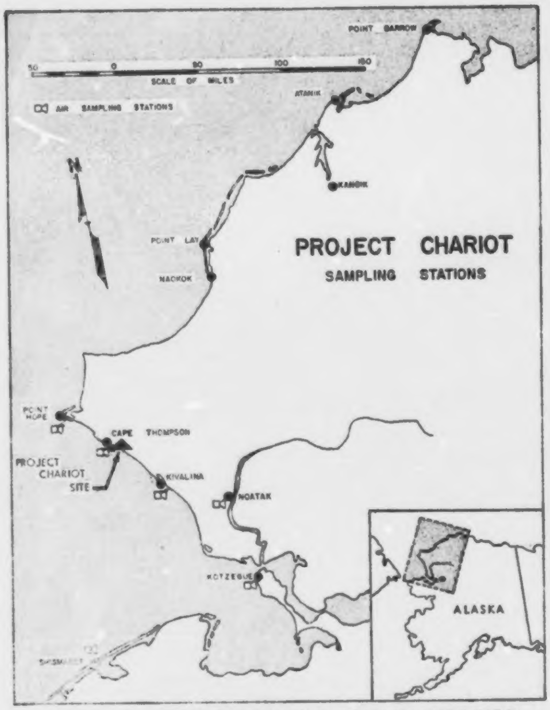

FIGURE 1.—PROJECT CHARIOT SAMPLING LOCATIONS

TABLE 1.—GROSS BETA ACTIVITY IN AIR NEAR THE PROJECT CHARIOT SITE, JANUARY-AUGUST 1962

[Average concentrations in $\mu\mu c/m^3$]

Location	Items	January	February	March	April	May	June	July	August
Cape Thompson	No. of samples	19	22	20	27	28	30	30	31
	Average beta	3.47	5.66	4.28	5.36	1.61	1.14	0.85	0.63
Kivalina	No. of samples	12	24	15	0	0	0	0	0
	Average beta	4.06	5.98	4.95					
Kotzebue	No. of samples	24	26	27	24	24	20	20	12
	Average beta	3.44	5.07	4.63	4.21	1.74	1.20	1.14	0.78
Noatak	No. of samples	0	0	0	11	7	0	14	13
	Average beta				2.27	1.49		0.73	1.09
Point Hope	No. of samples	21	28	30	21	25	30	29	23
	Average beta	4.36	6.08	4.68	4.01	1.77	1.15	0.77	0.74
Shishmaref	No. of samples	0	0	0	10	19	0	0	0
	Average beta				2.22	1.52			

Kotzebue and Point Hope, as shown in figure 1. During April 1962, two additional stations began operation. Monthly averages of gross beta activities in air for the period January–August 1962 are given in table 1.

Results of radiochemical analyses of water samples collected during September 1961 and May–August 1962 are presented in table 2. The samples are from drinking supplies unless otherwise indicated. No water samples were collected during the winter months October 1961 through April 1962.

TABLE 2.—RADIOCHEMICAL ANALYSIS OF WATER

[Concentrations in μμc/liter]

Location	Date of collection	Cs^{137}	Ba^{140}–La^{140}	Zr^{95}-Nb^{95}	Ru^{106}	I^{131}	Sr^{89}	Sr^{90}
Ogotoruk Creek	9/18/61	ND [*]	470	Trace			80	2
Kivalina	9/22/61	ND	240	ND			50	2
Kotzebue	9/23/61	ND	ND	ND			<5	<1
Cape Thompson (rain)	9/18-21/61	ND	1300	ND				
Point Hope	9/23/61	ND	ND	ND			<5	<1
Kivalina (snow)	5/1/62	ND	ND	ND	35	ND	95	9
Noatak	5/11/62	ND	ND	ND	ND	ND	50	<1
Point Hope	6/11/62	ND	ND	190	25		75	19
Noatak	6/11/62	ND	ND	45	65	ND	<5	1
Kotzebue	6/12/62	ND	ND	ND	ND	ND	<5	3
Kotzebue (rain)	6/12/62	ND	ND	80	35		45	28
Kivalina (rain)	6/25/62	ND	ND	165	30	ND	85	18
Shishmaref	6/30/62	ND	ND	70	ND	ND	55	10
Cape Thompson	7/2/62	ND	ND	ND	190	30	55	11
Cape Thompson	7/7/62	ND	ND	ND	ND	ND	<5	<1
Noatak (rain)	7/13/62	ND	ND	80	45	ND	35	7
Cape Thompson	7/17/62	<10	50	40		10	50	13
Shishmaref (rain)	7/20/62	<10	<20	<20		20		8
Kivalina	7/25/62	10	80	70		80	55	16
Point Hope	7/25/62	<10	<20	<20		10		6
Shishmaref	7/30/62	<10	<20	<20		20		
Cape Thompson	8/2/62	10	<20	40		<10	45	5
Noatak (rain)	8/20/62	65	40	300		<20	25	12
Point Hope (rain)	8/12/62	35	30	80		160	40	13
Kotzebue (rain)	8/26/62	15	<20	80		50	30	13

[*] ND indicates non-detectable.

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service • Division of Radiological Health

SECTION I.—AIR AND FALLOUT

Fission Product Beta Activity in Airborne Particulates and Precipitation

Surveillance of gross beta activity in air and precipitation permits quick and sensitive detection of fission product activity fluctuation in the environment. Although this information alone does not allow evaluation of biological effects due to fallout, it forms the basis of alerting systems and can be used as a rough index to determine when and where more extensive monitoring of radioactivity in food, milk, and water may be indicated.

November 1962 gross beta concentrations are presented in the following reports from the Radiation Surveillance Network, 80th Meridian (West) Sampling Program, Canadian Radioactive Fallout Study Program, and the Mexican Radioactive Fallout Program. Because of differences in equipment and techniques the results of one network are not directly comparable with those of another. A study conducted by Lockhart and Patterson of the U.S. Naval Research Laboratory has determined intercalibration factors for comparing the results of three networks (*1*, *2*). Using these factors a 1.00 $\mu\mu c/m^3$ reading by the Canadian Air Monitoring Network would correspond to 0.65 $\mu\mu c/m^3$ by the Radiation Surveillance Network and 1.12 $\mu\mu c/m^3$ by the NRL 80th Meridian Network (*2*). These factors are subject to the uncertainty of air volume measurements and may not hold for very young fission products.

REFERENCES

(*1*) Lockhart, L. B., Jr., and R. L. Patterson, Jr.: *Intercalibration of Some Systems Employed in Monitoring Fission Products in the Atmosphere, NRL Report 5850,* Washington, D.C. (November 13, 1962).

(*2*) Lockhart, L. B., Jr., and R. L. Patterson, Jr.: Intercalibration of Some Air Monitoring Systems, *Radiological Health Data, 3*:466–70, Superintendent of Documents, Government Printing Office, Washington 25, D.C. (December 1962).

RADIATION SURVEILLANCE NETWORK
November 1962

Division of Radiological Health,
Public Health Service

During November 1962, the Radiation Surveillance Network (RSN) comprised 72 sampling stations distributed among the fifty States, Guam, and Puerto Rico. RSN sampling stations are manned predominantly by State Health Department personnel.

Air

Daily 24-hour air samples are collected by a high-volume air sampler with a 4-inch diameter carbon-loaded cellulose dust filter. Estimates of the beta activity of airborne particulates are derived by comparing portable survey meter count readings of these filters with readings taken from a known Sr^{90}–Y^{90} activity source. Counting is done 5 hours after collection to eliminate interference from naturally-occurring radon daughters. The Network's station operators maintain the daily national report by telephoning their field estimates to the Radi-

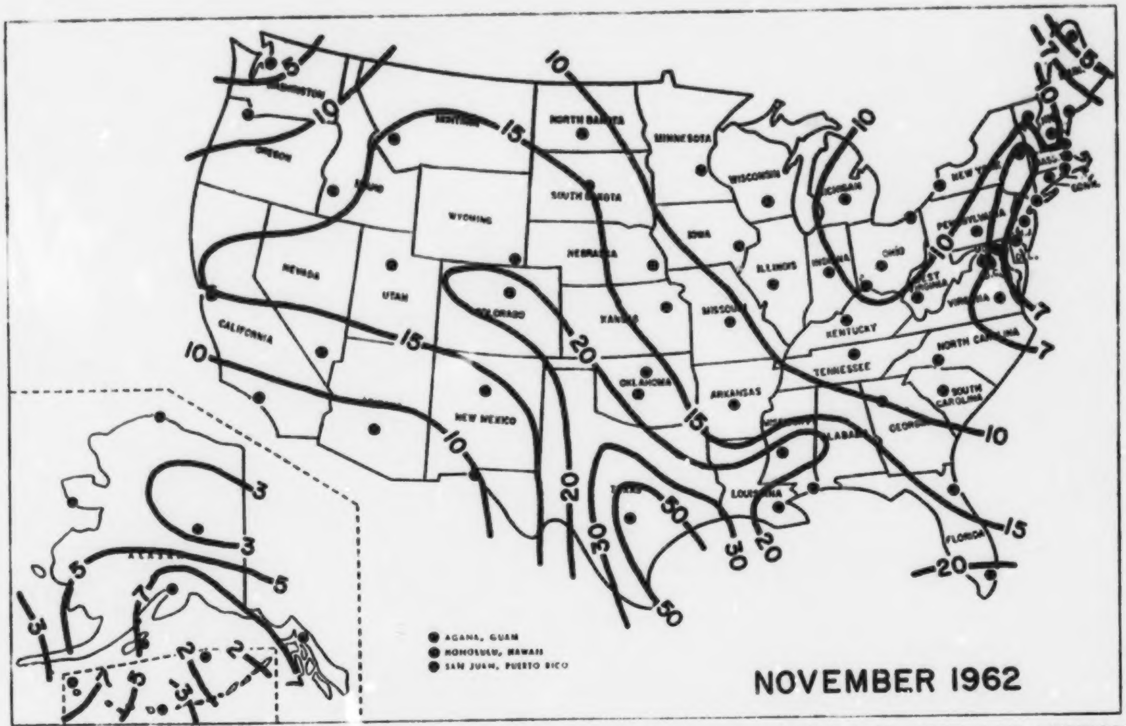

Figure 1.—RADIATION SURVEILLANCE NETWORK SAMPLING STATIONS AND AVERAGE FISSION PRODUCT BETA CONCENTRATIONS IN AIR ($\mu\mu c/m^3$) NOVEMBER 1962

ation Surveillance Center, Division of Radiological Health, Washington, D.C.

The filters are then forwarded to the Radiation Surveillance Network laboratory in Rockville, Maryland, for a more refined measurement using a thin-window gas-flow proportional counter. Each filter is counted at least 3 days after the end of the sampling period and re-counted 7 days later. The initial 3-day aging of the sample eliminates interference from naturally-occurring radon and thoron daughters. The two counts, separated by a 7-day interval, make possible the estimation of the age of fission products and extrapolation of the activity to the time of collection. The extrapolation is performed by using the Way-Wigner formula ($AT^{1.2}$ = constant).*

Although gross beta concentration is usually presented without reference to age, it is apparent that fission product activity is more adequately described when the age parameter is also given. Studies on determining a meaningful monthly average age of fission products are now in progress.

The average fission-product beta concentrations in surface air during November 1962, as determined by laboratory analysis and extrapolated to the time of collection, are given in table 1 and presented by means of concentration contours in figure 1.

Precipitation

Continuous sampling for total precipitation is conducted at most stations on a daily basis using funnels with collection areas of 0.4 m^2. A 500-ml aliquot of the collected precipitation is evaported to dryness, and the residue is forwarded to the laboratory to be counted by the same method used for analyzing the air samples. If the collected sample is between 200 and 500 ml, the entire sample is evaporated; if less than 200 ml (equivalent to 0.5 mm or 0.02 inches of rainfall), the volume of precipitation is reported, but no analysis is made. November 1962 averages of gross beta activity in precipitation, expressed in micromicrocuries per liter

---

* In this expression, A is the activity and T is the time after fission product formation.

TABLE 1.—GROSS BETA ACTIVITY OF PARTICULATES IN AIR, RSN, NOVEMBER 1962

[Concentrations in $\mu\mu c/m^3$]

Station location	Number samples	Maximum	Minimum	Average [a]	Last profile in RHD
Alaska: Adak	29	8.0	1.3	3.8	Nov 62
Anchorage	30	25	1.3	7.2	Jul 62
Attu	30	23	1.7	8.8	Dec 62
Fairbanks	8	5.5	1.3	2.5	Aug 62
Juneau	23	48	0.14	6.3	Sep 62
Kodiak	29	40	<0.10	7.0	Oct 62
Nome	20	19	0.46	4.1	Feb 63
Point Barrow Isl	13	10	1.5	3.3	Mar 63
St Paul Island	28	4.6	<0.10	1.9	
Ariz: Phoenix	29	18	3.6	8.2	Aug 62
Ark: Little Rock	28	30	1.2	12	Sep 62
Calif: Berkeley	29	93	1.8	15	Sep 62
Los Angeles	19	19	3.5	9.1	Feb 63
Colo: Denver	28	166	2.1	21	Oct 62
Conn: Hartford	30	34	0.94	8.4	Sep 62
Del: Dover	17	50	2.3	9.2	
D.C: Washington	30	22	0.73	6.2	Mar 63
Fla: Jacksonville	30	42	3.6	14	Sep 62
Miami	29	69	3.4	22	Feb 63
Ga: Atlanta	27	50	0.66	10	Jul 62
Guam: Agana	—	—	—	—	Mar 63
Hawaii: Honolulu	29	7.2	0.42	2.7	Nov 62
Idaho: Boise	29	42	2.7	12	Dec 62
Ill: Springfield	30	20	0.64	8.3	Oct 62
Ind: Indianapolis	29	23	0.95	8.8	Jul 62
Iowa: Iowa City	29	29	1.2	8.7	Nov 62
Kans: Topeka	29	45	2.3	12	Jul 62
Ky: Frankfort	28	23	0.57	8.7	Mar 63
La: New Orleans	29	112	1.3	17	Nov 62
Maine: Augusta	26	41	0.30	9.5	Mar 63
Presque Isle	30	21	0.17	4.0	
Md: Baltimore	19	40	1.4	9.4	Sep 62
Rockville	14	29	2.2	9.6	
Mass: Lawrence	28	30	0.74	7.5	Aug 62
Winchester	27	42	1.9	11	
Mich: Lansing	30	48	0.89	11	Jul 61
Minn: Minneapolis	28	21	2.2	7.4	Mar 63
Miss: Jackson	26	203	1.2	24	Mar 63
Pascagoula	19	49	1.4	16	Nov 62
Mo: Jefferson City	29	36	1.3	11	Dec 62
Mont: Helena	29	40	3.1	16	Nov 62
Nebr: Lincoln	24	66	0.54	12	
Nev: Las Vegas	25	47	1.9	13	
N.H: Concord	19	47	0.44	11	
N.J: Trenton	29	30	0.51	9.3	Oct 62
N. Mex: Santa Fe	28	113	2.1	13	Dec 62
N. Y: Albany	28	19	0.89	6.9	Jul 62
Buffalo	29	41	0.56	11	
New York	13	24	2.3	9.4	Dec 62
N.C: Gastonia	30	22	1.6	9.5	Oct 62
N. Dak: Bismarck	29	46	1.2	12	Feb 63
Ohio: Cincinnati	18	32	1.2	12	Jul 60
Columbus	29	43	1.4	14	Feb 63
Painesville	30	48	0.97	11	
Okla: Oklahoma City	27	149	0.78	19	Jul 61
Ponca City	29	37	0.43	6.9	Oct 62
Ore: Portland	28	49	0.84	8.8	Oct 62
Pa: Harrisburg	15	19	1.1	6.6	Dec 62
P.R: San Juan	27	9.9	0.33	3.5	
R.I: Providence	29	32	0.84	9.9	Nov 62
S.C: Columbia	27	25	1.3	8.2	Dec 62
S. Dak: Pierre	30	66	0.46	15	Sep 62
Tenn: Nashville	14	22	2.6	9.7	Feb 63
Tex: Austin	30	575	0.37	51	Aug 62
El Paso	29	60	3.3	10	Feb 63
Utah: Salt Lake City	30	109	3.0	19	Jul 62
Vt: Barre	29	37	0.30	10	
Va: Richmond	29	24	0.41	6.8	Aug 62
Wash: Seattle	28	22	1.3	5.3	Jul 62
W. Va: Charleston	24	23	1.6	8.3	
Wis: Madison	29	39	0.69	9.7	Aug 62
Wyo: Cheyenne	29	186	1.5	16	Aug 62
Network average				10.8	

[a] Weighted average obtained by summing the products of individual sampling times and the corresponding activities, and dividing by the summation of the individual sampling times.

TABLE 2.—GROSS BETA ACTIVITY IN PRECIPITATION, RSN, NOVEMBER 1962

Station location		Average concentration ($\mu\mu c$/liter)	Total deposition ($m\mu c/m^2$)
Alaska:	Adak	*	*
	Anchorage	2,000	18
	Attu	*	*
	Fairbanks	3,200	2.0
	Juneau	5,400	370
	Kodiak	*	*
	Nome	*	*
	Point Barrow Isl	*	*
	St Paul Island	*	*
Ariz:	Phoenix	*	*
Ark:	Little Rock	3,400	230
Calif:	Berkeley	2,100	53
	Los Angeles	*	*
Colo:	Denver	930	5.9
Conn:	Hartford	2,100	150
Del:	Dover	*	*
D.C:	Washington	2,200	150
Fla:	Jacksonville	1,300	51
	Miami	1,500	94
Ga:	Atlanta	1,300	120
Guam:	Agana	*	*
Hawaii:	Honolulu	*	*
Idaho:	Boise	7,500	340
Ill:	Springfield	1,500	13
Ind:	Indianapolis	5,400	140
Iowa:	Iowa City	1,600	45
Kans:	Topeka	2,000	18
Ky:	Frankfort	2,300	120
La:	New Orleans	1,900	150
Maine:	Augusta	2,600	460
	Presque Isle	1,300	140
Md:	Baltimore	3,700	73
	Rockville	*	*
Mass:	Lawrence	1,800	190
	Winchester	2,000	220
Mich:	Lansing	5,600	47
Minn:	Minneapolis	3,500	34
Miss:	Jackson	2,400	74
	Pascagoula	480	2.4
Mo:	Jefferson City	2,900	48
Mont:	Helena	6,500	88
Nebr:	Lincoln	6,800	82
Nev:	Las Vegas	*	*
N.H:	Concord	*	*
N.J:	Trenton	900	16
N. Mex:	Santa Fe	1,500	54
N.Y:	Albany	3,700	200
	Buffalo	480	150
	New York	*	*
N.C:	Gastonia	530	64
N. Dak:	Bismarck	12,000	68
Ohio:	Cincinnati	*	*
	Columbus	2,100	130
	Painesville	4,400	320
Okla:	Oklahoma City	1,300	2.5
	Ponca City	4,700	150
Ore:	Portland	520	4.5
Pa:	Harrisburg	1,200	74
P.R:	San Juan	550	42
R.I:	Providence	1,800	200
S.C:	Columbia	690	87
S. Dak:	Pierre	*	*
Tenn:	Nashville	6,300	50
Tex:	Austin	11,000	370
	El Paso	5,700	17
Utah:	Salt Lake City	2,100	39
Vt:	Barre	4,500	340
Va:	Richmond	1,400	170
Wash:	Seattle	4,300	430
W. Va:	Charleston	2,600	260
Wis:	Madison	5,400	31
Wyo:	Cheyenne	1,800	20

* No evaporated sample received

($\mu\mu c$/liter) and millimicrocuries per square meter ($m\mu c/m^2$), are presented in table 2.

Profiles

Profiles of the monthly average fission product beta activity in airborne particulates for each RSN station covering the period of time from the formation of the network in 1956 to the end of 1960 were published in *RHD*, July 1961. Profiles of 7 stations, updated through November 1962, are shown in figure 2. An index giving the *RHD* issue having the most recent profile for each station is given in the last column of table 1.

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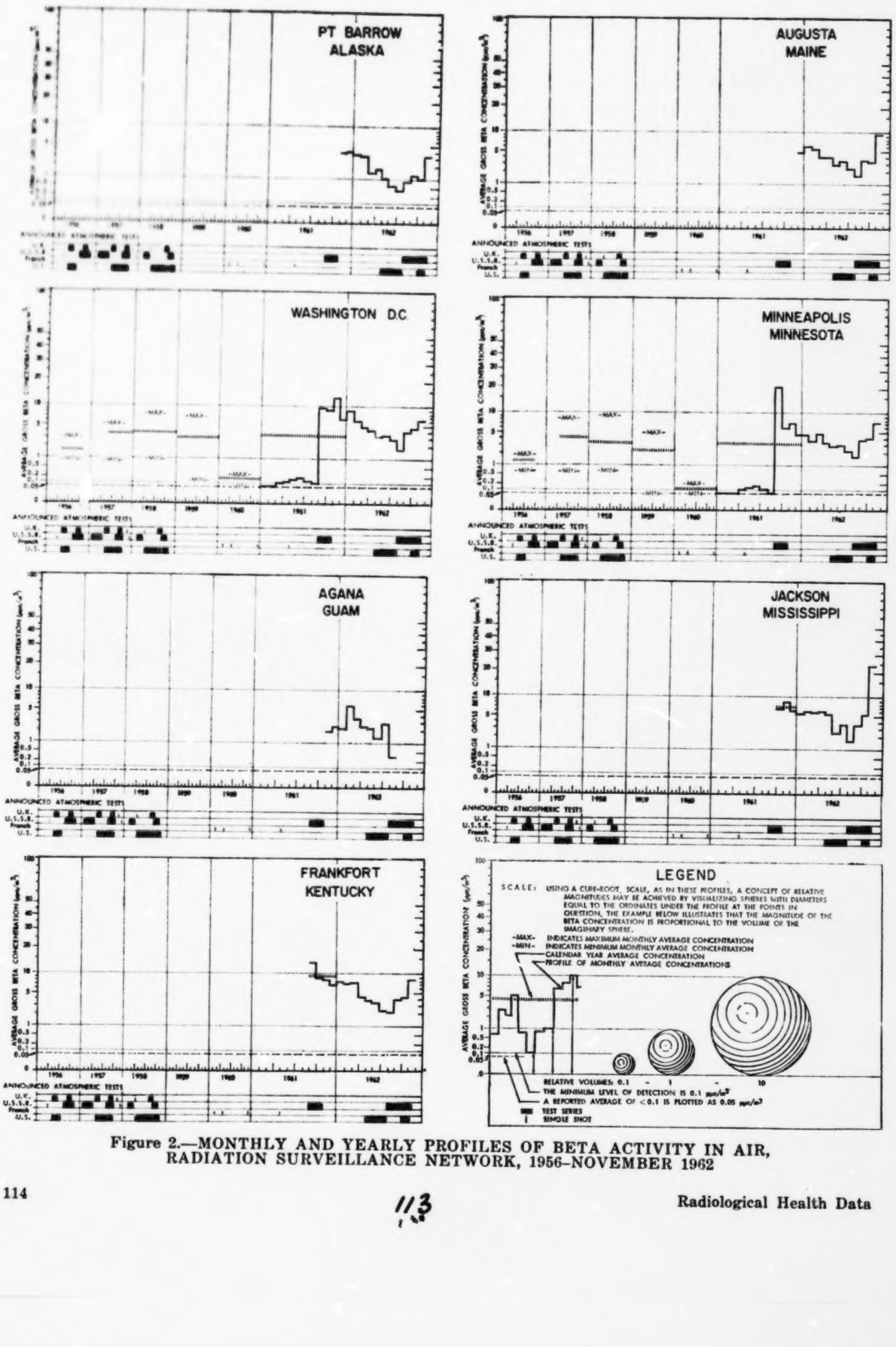

Figure 2.—MONTHLY AND YEARLY PROFILES OF BETA ACTIVITY IN AIR, RADIATION SURVEILLANCE NETWORK, 1956–NOVEMBER 1962

THE 80TH MERIDIAN (WEST) SAMPLING PROGRAM
November 1962

U.S. Naval Research Laboratory

Radioactivity measurements of surface air samples collected at various sites (see figure 3) near the 80th Meridian (West) have been made since 1956 by the U.S. Naval Research Laboratory (NRL),* with the cooperation of interested agencies of the United States, Canada, Ecuador, Peru, Bolivia, and Chile, which collect the samples and forward them to NRL for analysis. Partial financial support of this program is provided by the Division of Biology and Medicine, U.S. Atomic Energy Commission.

The sampling procedure involves drawing air continuously for a 7-day period at a rate of approximately 1200 cubic meters per day through an 8-inch diameter, high-efficiency filter, using a positive-displacement blower. After the 7-day period, the filter is removed and forwarded to NRL for assay of gross beta activity. A minimum of 2 weeks after collection is allowed for decay of short-lived radionuclides. November 1962 data in table 3 are not extrapolated to time of collection.

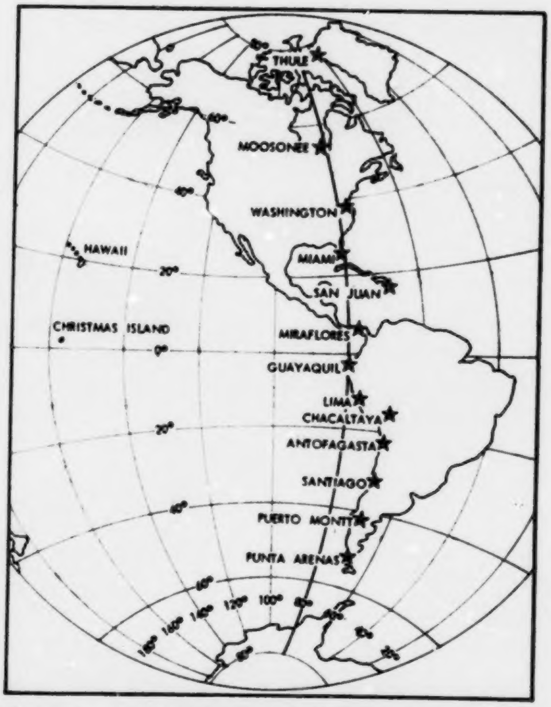
THULE
MOOSONEE
WASHINGTON
HAWAII
MIAMI
SAN JUAN
CHRISTMAS ISLAND
MIRAFLORES
GUAYAQUIL
LIMA
CHACALTAYA
ANTOFAGASTA
SANTIAGO
PUERTO MONTT
PUNTA ARENAS
60°
40°
20°
0°
20°
40°
60°
180°
160°
140°
120°
100°
80°

Figure 3.—ATMOSPHERIC RADIOACTIVITY SAMPLING STATIONS NEAR THE 80TH MERIDIAN (WEST)

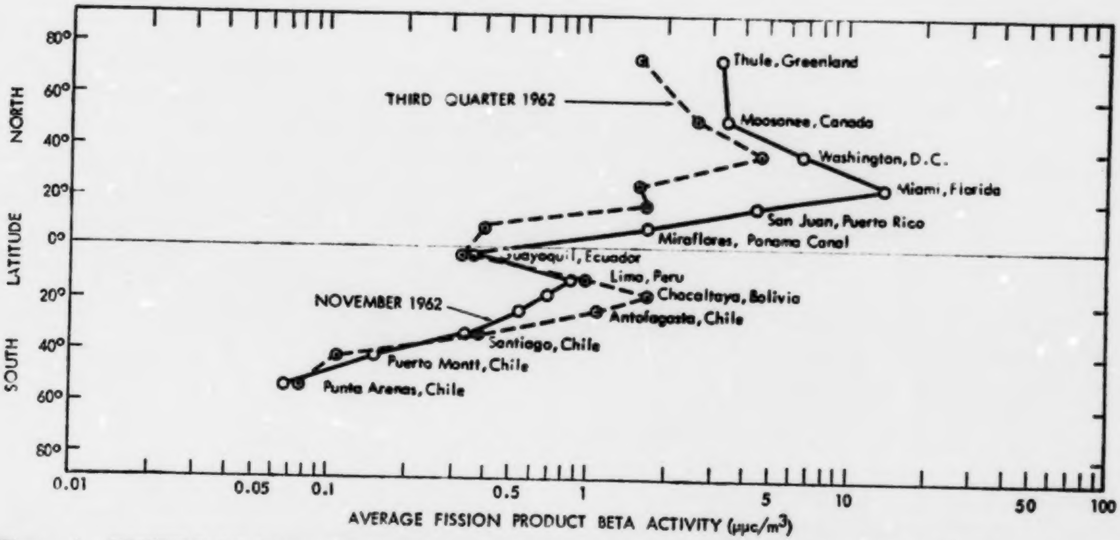

Figure 4.—PROFILE OF BETA ACTIVITY, AVERAGE MEASUREMENT OF SURFACE AIR AT STATIONS NEAR THE 80TH MERIDIAN (WEST), NOVEMBER 1962

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* *Editor's note:* Effective January 1, 1963, administration of the 80th Meridian (West) Sampling Program was turned over to the Health and Safety Laboratory, Division of Biology and Medicine, AEC, by the U.S. Naval Research Laboratory.

TABLE 3.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, NRL[a] NOVEMBER 1962

[Average concentrations in $\mu\mu c/m^3$]

November 1962	Punta Arenas, Chile	Puerto Montt, Chile	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador	Miraflores, Panama Canal Zone	San Juan, P.R.	Mauna Loa, Hawaii[c]	Miami, Florida	Washington, D.C.	Moosonee, Canada	Thule, Greenland
1 2 [illegible] 4 5	0.069	0.167	0.290	0.711	0.662	0.752	0.102	0.144	1.42	2.07	6.62	3.31	1.86	2.12
6 7 8 9 10 11 12	0.068	0.144	0.333	0.662	1.05	0.914	0.391	2.56	2.02	2.41	19.0	5.26	3.71	2.27
13 14 15 16 17 18 19	0.101	0.198	0.554	0.348	0.368	0.720	0.459	2.92	6.75	4.25	12.7	8.19	2.37	3.13
20 21 22 23 24 25 26	0.035	0.148	0.287	0.477	0.778	0.886	[b]—	0.969	6.08	8.64	18.4	4.72	2.96	3.41
27 28 29 30	0.050	0.126	0.327	0.477	0.468	—	—	2.03	5.18	5.26	8.73	14.9	6.98	5.00
Weighted average	0.066	0.159	0.366	0.526	0.684	0.824	0.340	1.78	4.39	4.64	14.0	6.80	3.35	3.08

[a] The average concentration determined from a given sample is placed at the center of a rectangle which indicates the length and dates of the sampling period. Station averages for the month were determined by weighting the sample average according to the number of days in the sampling period or that portion of the sampling period occurring in November 1962.

[b] Dash indicates samples were not received.

[c] Mauna Loa data have been included for comparison with Chacaltaya, Bolivia. Both are high elevation stations (3400 and 5200 meters, respectively) and about equally distant north and south of the equator.

CANADIAN RADIOACTIVE FALLOUT STUDY PROGRAM

November 1962

Department of National Health and Welfare, Ottawa, Canada

As part of its Radioactive Fallout Study Program (RFSP), the Radiation Protection Division, Department of National Health and Welfare, Dominion of Canada, conducts air and precipitation sampling programs. The 24 air and precipitation stations are located at airports (see figure 5), and the equipment is operated by meteorologists of the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in the Department's reports (*1–5*).

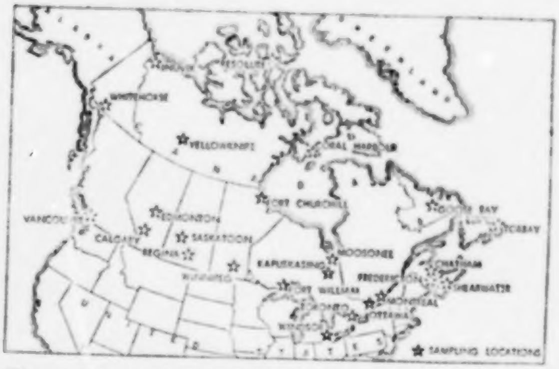
WHITEHORSE
RESOLUTE
YELLOWKNIFE
CORAL HARBOUR
FORT CHURCHILL
GOOSE BAY
TORBAY
VANCOUVER
EDMONTON
CALGARY
SASKATOON
REGINA
WINNIPEG
KAPUSKASING
MOOSONEE
CHATHAM
FREDERICTON
FORT WILLIAM
MONTREAL
OTTAWA
TORONTO
WINDSOR
SAMPLING LOCATIONS

Figure 5.—CANADIAN AIR AND PRECIPITATION SAMPLING STATIONS

Precipitation

The amount of radioactive fallout being deposited on the ground is determined from measurements on material collected in special polythene lined rainfall pots. After transfer of the water to the sampling container, the polythene liner is removed, packed with the sample, and sent to the laboratory. November 1962 precipitation data, including some radiochemical analyses, are presented in table 4.

Air

About 650 cubic meters of air are drawn through a high-efficiency 4-inch-diameter filter during a 24-hour period. Filters are sent daily to the Radiation Protection Division Laboratory in Ottawa. A 2-inch-diameter disk is removed from each filter and counted with a thin end-window Geiger flow counter system, calibrated with a Sr^{90}–Y^{90} standard. Four successive measurements are made on each filter to allow for the presence of natural activities and for the decay of short-lived fission products. The result is extrapolated to the end of the sampling period. Air data for November 1962 are presented in table 5.

TABLE 4.—FISSION PRODUCT GROSS BETA ACTIVITY IN PRECIPITATION, RFSP, NOVEMBEP 1962

Station	Total beta activity		Deposition of specific radionuclides for selected samples[1,2] (mμc/m²)				
	μμc/liter	mμc/m²	Sr^{89}	Sr^{90}	Zr^{95}	Cs^{137}	Ba^{140}
Calgary	1,730	7.4	1.87	0.18	7.40	0.39	—
Chatham	2,390	275					
Coral Harbour	1,520	18					
Edmonton	7,170	69					
Fredericton	1,800	183					
Ft. Churchill	1,420	47					
Ft. William	3,450	92					
Goose Bay	1,160	134					
Inuvik	3,240	44					
Kapuskasing	1,810	82					
Montreal	4,440	183	13.9	0.43	26.6	0.58	26.5
Moosonee	1,960	93					
Ottawa	3,690	224					
Regina	11,700	69					
Resolute	7,690	391					
Saskatoon	5,210	68					
Shearwater	1,710	311	15.8	0.49	47.2	0.81	27.8
Torbay	888	203					
Toronto	1,730	111					
Vancouver	3,040	570	41.2	1.76	94.2	1.86	81.5
Whitehorse	2,050	46					
Windsor	2,120	103					
Winnipeg	1,650	90	8.06	0.42	15.1	0.51	14.4
Yellowknife	1,280	37					
Average	3,120	144					

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[1] All values corrected for decay back to end of collection month.

[2] Values for strontium-90, cesium-137, and zirconium-95 do not include the activities of their daughter isotopes, yttrium-90, barium-137, and niobium-95.

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TABLE 4.—FISSION PRODUCT GROSS BETA ACTIVITY IN AIR, RFSP, NOVEMBER 1962

[Average concentrations in $\mu\mu c/m^3$]

Station	Number of Samples	Maximum	Minimum	Average
Calgary	19	105.0	1.8	25.8
Chatham	29	37.0	0.9	9.4
Coral Harbor	29	57.0	0.4	7.6
Edmonton	30	46.0	0.5	13.6
Ft. Churchill	30	12.3	0.8	5.3
Ft. William	29	84.0	1.8	16.5
Fredericton	30	43.0	0.4	10.5
Goose Bay	30	23.0	0.2	6.1
Inuvik	30	19.0	2.8	7.0
Kapuskasing	19	17.0	2.7	7.5
Montreal	29	38.0	0.5	11.7
Moosonee	27	37.0	0.9	7.5
Ottawa	29	59.0	2.5	15.3
Regina	30	73.0	2.1	17.7
Resolute	4	33.0	0.8	11.1
Saskatoon	30	65.0	0.9	13.9
Shearwater	29	34.0	0.0	11.3
Torbay	28	31.0	0.2	6.3
Toronto	30	47.0	0.9	14.1
Vancouver	29	73.0	2.0	13.7
Whitehorse	29	83.0	2.2	13.5
Windsor	30	60.5	3.1	17.0
Winnipeg	30	62.0	0.9	12.7
Yellowknife	30	13.3	2.2	6.2
Average				11.7

Recent coverage in *Radiological Health Data*:

Period	Issue
First quarter 1961	*December 1961*
Second quarter 1961	*February 1962*
Third quarter 1961	*May 1962*
Fourth quarter 1961	*September 1962*
First quarter 1962	*October 1962*
Second and third quarters 1962	*January 1963*
October 1962	*February 1963*

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(1) Bird, P. M., A. H. Booth, and P. G. Mar: *Annual Report for 1959 on the Radioactive Fallout Study Program, CNHW (RPD-3)*, (May 1960).

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(3) Mar, Peter G.: *Outline of Procedure for the Radiochemical Analysis of Dried Milk Powders for Strontium and Yttrium, CNHW (RPD-5)*, (June 1, 1960).

(4) Beale, J., and J. Gordon: *The Operation of the Radiation Protection Division Air Monitoring Program, CNHW (RPD-11)*, (July 1962).

(5) Booth, A. H.: *The Calculation of Maximum Permissible Levels of Fallout in Air and Water and Their Use in Assessing the Significance of 1961 Levels in Canada, CNHW (RPD-21)*, (August 1962).

MEXICAN RADIOACTIVE FALLOUT PROGRAM

October and November 1962

Radiation Protection Program,
National Commission of Nuclear Energy,
Mexico

The Radiation Surveillance Network of Mexico was established by the "Comisión Nacional de Energía Nuclear" (C N E N) through its Radiological Protection Program (RPP) in 1961 to provide a means for determining increased levels of radioactivity in air and precipitation due to fallout from nuclear tests.

Prior to the establishment of the network, two pilot sampling stations were set up in México, D. F. (Mexico City) and San Luis Potosí to aid in the selection of equipment and sampling sites. Since April 1962 the network has been expanded to twelve stations, ten of which were in operation by the end of November 1962 (see figure 6).

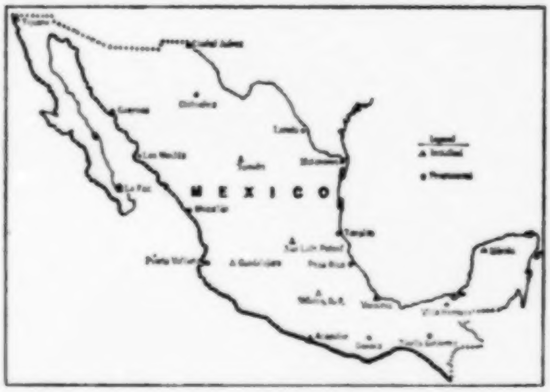

Figure 6.—FALLOUT NETWORK SAMPLING STATIONS IN MEXICO

Seven of the ten sampling stations are located at airports and are operated by airline personnel. The remaining three stations are located at Mexico City, Merida, and Veracruz. Staff members of the RPP operate the station at Mexico City, while the other two stations are manned by members of the "Centro de Previsión del Golfo de México."

Sampling

The sampling procedure involves drawing air 24 hours a day, 3 or 4 days a week at the rate of approximately 1,200 cubic meters per day, through a high-efficiency glass fiber filter, 6" × 8", using high volume samplers. After each 24-hour period the filter is removed and forwarded via airmail to the "Laboratorio de Desechos Radiactivos," CNEN, in Mexico City for assay of gross beta activity. A minimum of 3 or 4 days after collection is allowed for decay of radon and thoron daughters. Data are not extrapolated to time of collection.

The maximum, minimum, and average fission product beta concentrations in surface air during October and November 1962 are presented in table 6.

TABLE 6.—GROSS BETA ACTIVITY OF AIRBORNE PARTICULATES, MEXICO, OCTOBER-NOVEMBER 1962

[Concentrations in $\mu\mu c/m^3$]

Month	Station	Number	Maximum	Minimum	Average
October	Acapulco	4	1.9	0.1	0.7
	Ciudad Juárez	8	34.5	2.7	15.0
	La Paz	7	12.1	1.9	5.6
	Mérida	13	8.1	0.1	2.9
	México, D.F	8	0.6	0.1	0.3
	San Luis Potosí	11	6.0	0.1	2.0
	Torreón	10	8.5	0.2	1.9
	Veracruz	13	12.0	0.1	4.6
	Guadalajara	9	2.6	0.1	0.6
November	Ciudad Juárez	7	25.4	4.9	13.4
	Guadalajara	12	13.6	1.6	5.9
	La Paz	7	12.3	1.7	4.2
	Mérida	10	94.2	2.1	20.7
	México, D.F	8	36.3	0.6	9.6
	San Luis Potosí	12	31.4	0.7	9.9
	Torreon	8	35.7	3.0	17.4
	Veracruz	12	57.5	3.8	20.3
October-November Average					7.9

Meteorology of Airborne Fission Product Radioactivity in the Mexican Republic[1]

I. G. Galindo Estrada
Programa de Proteccíon Radiologica de la
Comisión Nacional de Energía Nuclear, México

In this report, categories and types of meteorological patterns prevalent in the Mexican Republic are reviewed and compared with particulate fission product gross beta activity in surface air. The meteorological analysis was based on five-year records of surface and higher altitude winds[2] (700 and 500 millibars) and on the classification proposed by Mosiño (*1*) for the patterns of atmospheric circulation over the Mexican Republic.

Meterologic Configuration

The Mexican Republic is situated in the tropical and extratropical zones (14–33° N). However, because of the position of mountain formations (figure 1), trade winds prevail over the country during some periods but westerly winds coming from temperate latitudes are also observed.

In order to analyze the prevalent weather patterns, Mexican meteorologists have proposed, on the basis of surface weather mapping, three major categories of atmospheric circulation:

1. Cyclonic types
2. Anticyclonic types
3. "Norte" incursions

These categories are analyzed as follows.

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[1] Summarized from the paper by I. G. Galindo Estrada, "The Meteorology of the Mexican Republic and its Relation to the Program of Radiologic Protection," (9 references), presented at the Fourth Inter-American Symposium on the Peaceful Application of Nuclear Energy, April 1962, Mexico City, Mexico.

[2] Data collected and analyzed by Radio Aeronautica Mexicana, S.A. (RAMSA) and the Servicio Meteorológica Mexicano.

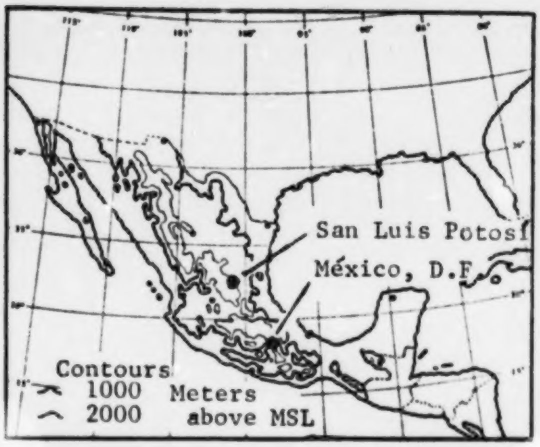

Figure 1.—TOPOGRAPHY OF MEXICO

Cyclonic Types

Some of these low pressure areas (counterclockwise motion) are of tropical origin, following an east to west direction from the Caribbean Sea. They may or may not have an incipient frontal wave (figure 2), with great cloudy masses that eventually precipitate along the frontal zone, washing the atmosphere and carrying to the earth surface airborne particles (washout). These patterns arise more frequently during the winter and spring (January to June).

Another tropical cyclonic pattern is observed during the summer (figure 3), a low pressure area over the Gulf of Mexico affecting the northern portion of the Mexican territory.

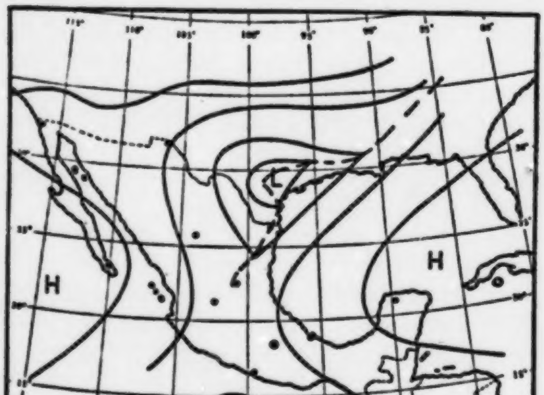

Figure 2.—WINTER AND SPRING CYCLONE

The continental portion of the country receives a low pressure pattern, called the leeward mountain trough (figure 4), originating on the eastern side of the Rocky Mountains and the Sierra Madre Oriental. Finally a depression at 700 millibars may occur over the plateau region as is evidenced by the surface low shown in figure 5.

Anticyclonic Types

These are high pressure areas characterized by moderate central winds variable in direction and generally accompanied by good weather. They are related to the presence of the trade winds over the Gulf of Mexico, with paths approximately perpendicular to the main moun-

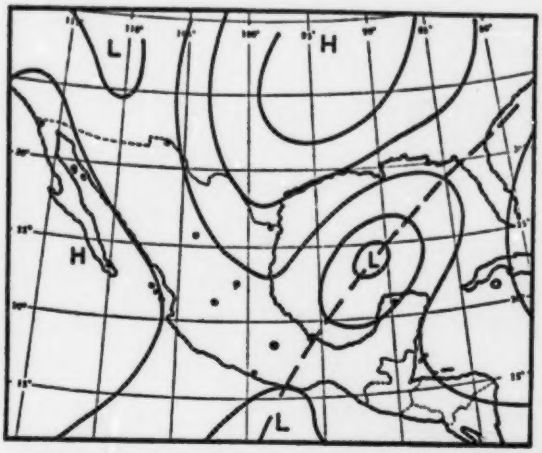

Figure 3.—TROPICAL SUMMER CYCLONE

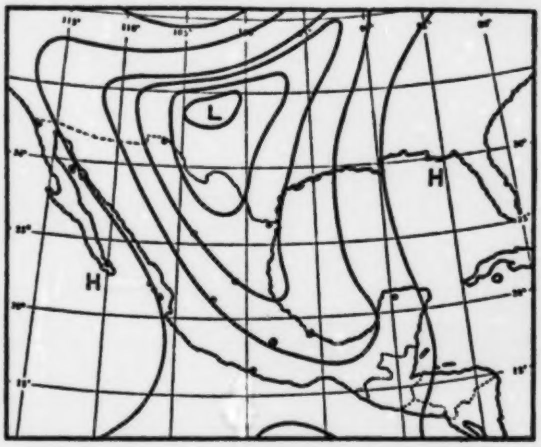

Figure 4.—LEEWARD MOUNTAIN TROUGH

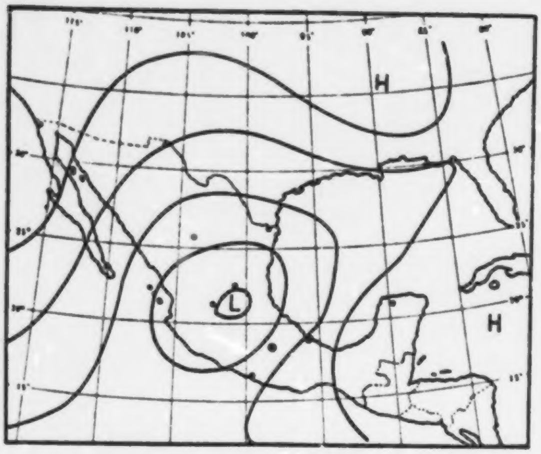

Figure 5.—PLATEAU DEPRESSION

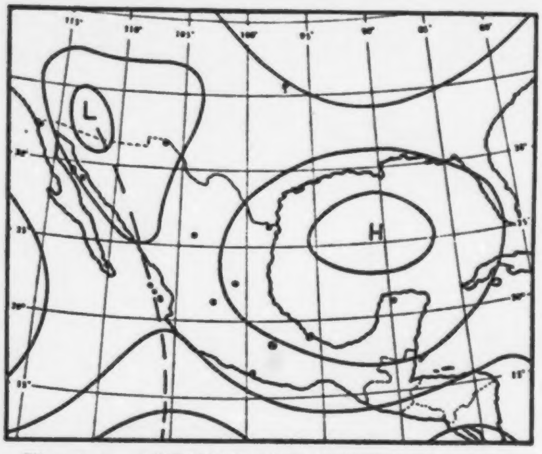

Figure 6.—ANTICYCLONE CENTERED OVER THE GULF OF MEXICO

tain chains. Their frequency increases during summer months (July to September) (figure 6 and 7).

"Norte" Incursions

These are incursions of modified polar continental air over the Gulf of Mexico. They reach Mexican territory from the northeastern portion of the Gulf and affect the coastal plains and the northern zone of the country, touching Veracruz and then dissipating over deep sea. These incursions are sometimes so extensive that they involve the total area of the Gulf and also the Peninsula of Yucatan (figures 8 and 9). These high pressure areas following the cold front originate over the south part of the

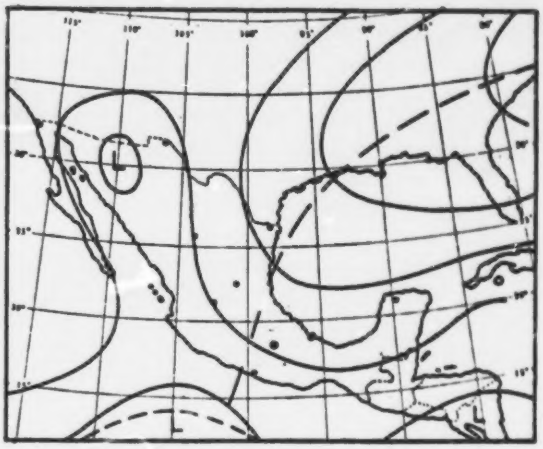

Figure 7.—ANTICYCLONE CENTERED OVER THE EAST COAST, UNITED STATES

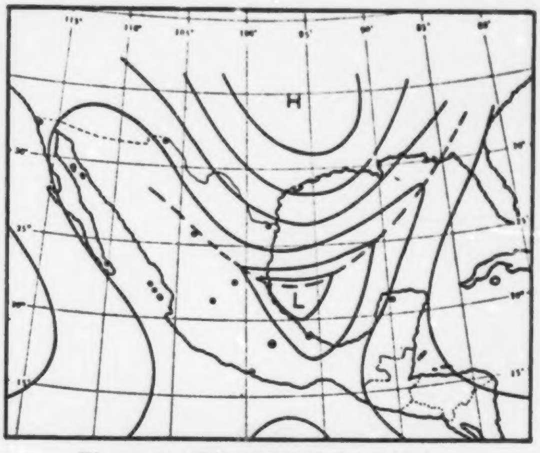

Figure 8.—INCURSION OF POLAR CONTINENTAL AIR

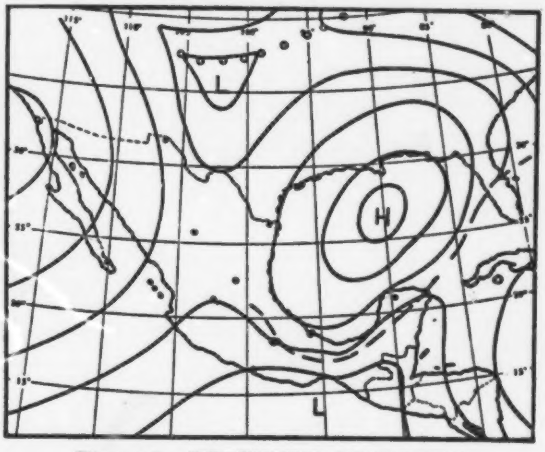

Figure 9.—EXTENSIVE INCURSION OF POLAR AIR

United States and sometimes over higher latitudes (central portion of the United States). They occur more frequently during the winter months November to January and the transitional seasons. The "Nortes" are characterized by strong northerly surface winds over the main body of the Gulf. Hurricane gusts blowing southerly from Veracruz through the Isthmus of Tehuantepec are sometimes also present.

A study of the meteorologic patterns discussed above may prove to be an important aid in predicting the paths of debris clouds over the country.

Relationship between the Prevailing Synoptic Situations and the Profiles of Gross Radioactivity

During the period of observation, the Comisión Nacional de Energía Nuclear (CNEN) had two monitoring stations, one located in Mexico City and the other in San Luis Potosi, both functioning since October 1961 (2). Figure 10 shows particulate beta concentrations in air during 6 months at each station (September 1961–February 1962). Table 1 shows the frequency of the described meterologic cate-

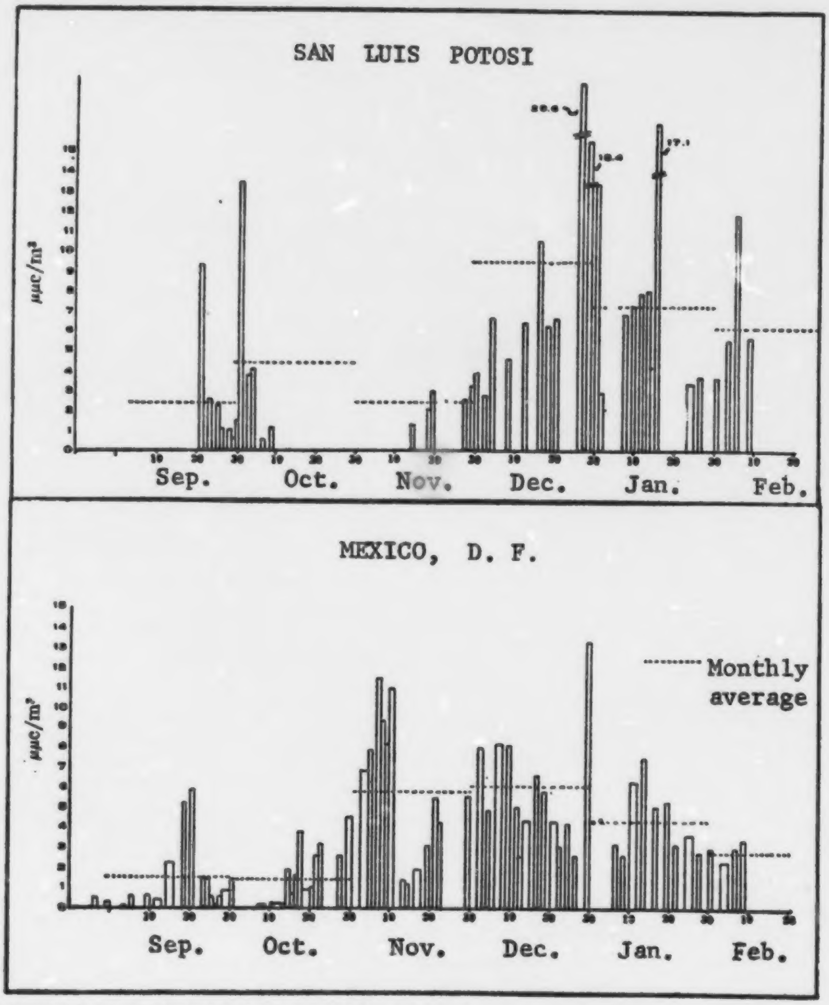

Figure 10.—PROFILES OF AIRBORNE FISSION PRODUCT RADIOACTIVITY AT TWO LOCATIONS IN MEXICO, SEPTEMBER 1961–FEBRUARY 1962

TABLE 1.—RELATIVE FREQUENCY OF PREVALENT WEATHER PATTERNS AND PROFILES OF RADIOACTIVITY IN THE ATMOSPHERE AT TWO LOCATIONS IN MEXICO, OCTOBER 1961—MARCH 9, 1962

[Concentrations in $\mu\mu c/m^3$]

Station	Prevalent weather patterns		Frequency	Concentration	
	Category	Type		Minimum	Maximum
Mexico City	Cyclonic types	1	5	0.13	3.43
		2	8	0.11	7.54
		3	7	0.10	2.80
		4	7	0.27	5.29
		5	1	0.37	0.37
		1-5	28 (39%)	0.10	7.54
	Anticyclonic types	6	5	0.64	6.90
		7	6	0.62	8.10
		6, 7	11 (15%)	0.62	8.10
	"Norte" incursions	8	18	0.16	13.49
		9	5	0.01	5.47
		10	10	0.08	13.47
		8-10	33 (46%)	0.01	13.49
San Luis Potosi	Cyclonic types	1	2	2.93	4.69
		2	3	0.33	6.10
		3	7	0.34	5.60
		4	3	0.61	3.29
		5	0	—	—
		1-5	15 (35%)	0.33	6.10
	Anticyclonic types	6	6	2.75	10.76
		7	4	1.19	6.22
		6, 7	10 (23%)	1.19	10.76
	"Norte" incursions	8	8	3.83	17.10
		9	4	2.84	29.64
		10	6	0.62	18.43
		8-10	18 (42%)	0.62	29.64

gories and pattern types during the period of study. It can be observed in both figures that the major concentrations of radioactivity were recorded during the winter (December to February). These peaks correspond fundamentally to "Norte" incursions. This might be expected in view of the fact that the announced U.S.S.R. nuclear detonations occurred in the north temperate and polar zones and the U.S. underground tests occurred in Nevada.

REFERENCES

(*1*) Mosiño, P.: Una Clasificacion de las Configuraciones del Flujo Aéreo en la República Mexicana, *Rev. de Ing. Hid. en Méx.*, *12*:2 (1958).

(*2*) National Commission of Nuclear Energy: Mexican Radioactive Fallout Program, October 1961–September 1962, *Radiological Health Data*, *3*:68–9 (February 1963).

SECTION II.—FOOD

Editor's note: There are two necessary steps in determining the dietary intake of radionuclides by a population. First, reliable data on the quantity of food items consumed must be obtained. Secondly, the radionuclide concentrations in these foods must be determined. This article contains recent consumption data for selected food items and includes examples of how the dietary intake of radionuclides may be calculated from such data.

Consumption of Selected Food Items in U.S. Households
July 1962

Bureau of the Census, Department of Commerce, and
Division of Radiological Health, Public Health Service

The following data cover the five food items included in the methodological survey conducted by the Bureau of the Census in July 1962 on behalf of the Public Health Service. The National Food Consumption Survey is a part of the Quarterly Household Survey conducted during the first two weeks of each quarter (July, October, January, and April). This survey covers a representative sample of the United States population to provide estimates of the amounts and kinds of foods consumed according to various personal and demographic characteristics and is jointly supported by the Division of Radiological Health (DRH), and the Heart Disease Control Program (HDCP), Division of Chronic Diseases of the Public Health Service.

The program was designed initially to develop the methods and procedures for the collection of data related to individual con-

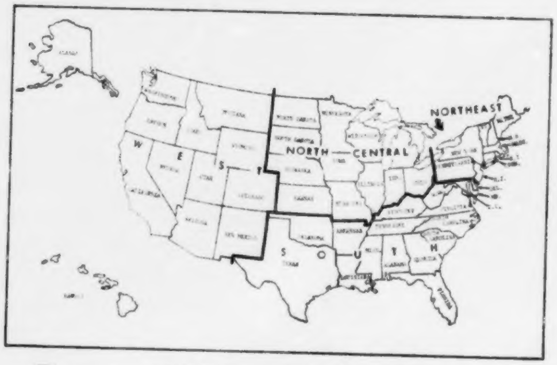

Figure 1.—CENSUS REGIONS OF THE U.S.

sumption of selected food items. In subsequent months similar information will be gathered on additional selected food items and the components of the total diet.

Design of Survey

In July, the Food Consumption Survey was conducted in every State and the District of Columbia. This sample contained a total of approximately 11,500 housing units (both occupied and vacant) and completed interviews were obtained in approximately 8,900 of these, containing about 28,000 persons. The January 1963 issue of *Radiological Health Data* contains a detailed discussion of the survey.

One limitation of the procedure was that it was not feasible (because of other commitments in the Census survey) to randomize the interviews by day of the week. To the extent that consumption patterns vary significantly by day of the week, additional errors may be introduced. The figures in the tables are based only on the results of the personal interviews—both the three-day recall and the one-day recall; final results of the diary approach are not as yet available. Examination of preliminary data obtained by diary, however, indicates no substantial differences.

Results and Discussion

While no conclusions may be reached about total milk consumption as these data are limited to consumption "at home," the mean values by age in table 1 indicate that males consume more milk than females in each age group (see January 1963 issue of *RHD* for percentage distribution of the population by milk consumption categories). This observation is also true for white bread and beef as indicated in tables 2 and 3. The distribution of the population shown in tables 2 through 5 indicates a relatively high percentage of no consumption on an average day during the period. While the survey itself does not provide answers to questions that might be raised about this point, it should be recognized that this may be explained by consumption taking place "away from home," and the many substitutes available for the specific items in the survey.

TABLE 1.—AVERAGE DAILY "AT HOME" CONSUMPTION OF WHOLE MILK BY SEX AND AGE, JULY 1962 SURVEY

Age	Male		Female	
	Number of observations	Mean (fluid ounces)	Number of observations	Mean (fluid ounces)
All ages	32,012	11.7	33,568	8.5
Under 1	713	17.8	747	16.2
1-4	3,073	17.9	2,890	17.0
5-9	3,744	16.2	3,536	15.1
10-14	3,577	17.2	3,399	12.9
15-19	2,592	17.2	2,661	9.9
20-24	1,678	11.9	1,984	7.2
25-29	1,614	9.9	1,807	6.5
30-34	1,976	8.9	2,094	5.6
35-44	4,233	8.2	4,674	5.4
45-54	3,567	7.7	3,695	5.2
55-64	2,584	8.1	2,840	5.7
65+	2,661	8.3	3,241	6.5

Tables 6 through 10 show both the distribution of the population by consumption categories and region of the country (see figure 1) and mean values for the same five food items. In general, the Southern region showed the lowest mean values for these particular items with the Northeastern region indicating the highest consumption.

Use in Radioactivity Intake Estimates

Plans are to combine food consumption estimates obtained from the survey with radionuclide concentration data produced by the Division of Radiological Health's National Dietary Assessment Program and from these to calculate estimates of radionuclide intake from the diet. These data will provide an empirical basis for comparisons with appropriate radiation protection guides on intake of radioactive materials. The program is also designed to determine the feasibility of using an "indicator food list" for the surveillance and assessment of radionuclide intake.

It should be noted that the data reported below are limited to "at home" consumption as reported in the July test. This, of course, precludes their use as a basis for estimating total radiation intake from the consumption of these items. The January 1963 Quarterly Household Survey, which covered ten food items, also included "away from home" consumption for the first time. Since the program objective is to produce dietary radionuclide intake estimates when complete consumption data are available, the following examples may be of interest.

In general, the procedure is to multiply mean consumption estimates by population-weighted radionuclide concentrations to obtain intake estimates. If the "at home" figure of 14.4 ounces shown in table 6 as the average daily milk consumption for males in the Northeast region for the first two weeks of July 1962 was the total consumption estimate, and if the population-weighted mean value of 23.4 μμc of iodine–131/liter of milk during this period was representative of the concentration of this radionuclide for the same population group, by converting the 14.4 ounces to 0.4258 liters and multiplying by 23.4 μμc/liter, an estimated intake of 10.0 μμc/day is obtained as the estimated average daily intake of iodine–131 from milk for this population group in this region for the stated period. The same approach will be used for other radionuclides such as strontium–90 where, for example, if the "at home" estimate of 6.9 fluid ounces shown in table 6 was the total average daily consumption of milk for females in the Southern region during the first two weeks of July 1962, and the population-weighted strontium–90 concentration of 20.1 μμc/liter of milk was representative of this radionuclide in the milk consumed by this population, then by converting the 6.9 ounces to 0.2040 liters, and multiplying it by 20.1 μμc/liter, an estimated average daily intake of 4.1 μμc/day of strontium–90 from milk would be obtained for this population group in this region for the stated period. Future issues of *RHD* will contain radionuclide intake data arrived at by the procedure illustrated above.

TABLE 2.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF WHITE BREAD BY SEX AND AGE, JULY 1962 SURVEY

Sex and age	Number of observations	Amount (slices)							Mean (slices)
		None	1-2	3-4	5-6	7-8	9-10	11+	
Male									
All ages	32,042	31.2	21.4	21.2	13.5	6.5	3.3	2.8	3.1
Under 1	711	87.3	9.8	2.0	0.4	0.4	0.2	—	0.3
1-4	3,075	28.8	39.5	21.1	7.0	2.3	0.7	0.6	1.5
5-9	3,747	23.3	25.4	27.6	14.5	5.9	2.0	1.3	2.6
10-14	3,580	26.0	17.9	21.8	15.9	8.0	5.0	5.6	3.9
15-19	2,596	29.7	15.8	17.9	16.9	8.6	5.5	5.6	3.9
20-24	1,680	31.7	14.5	19.2	15.8	8.5	4.5	5.9	3.8
25-29	1,615	35.1	15.9	19.7	13.1	8.8	4.2	3.3	3.2
30-34	1,978	29.0	19.4	20.6	14.0	9.1	4.2	3.9	3.4
35-44	4,239	30.6	20.2	20.7	14.3	7.4	4.0	2.9	3.2
45-54	3,568	32.1	20.6	19.9	14.4	7.2	3.7	2.1	3.1
55-64	2,593	35.2	18.5	21.5	12.8	6.4	3.8	1.7	2.9
65+	2,660	33.6	23.6	24.7	13.6	2.7	0.7	1.2	2.5
Female									
All ages	33,597	34.3	30.0	22.7	8.9	2.6	0.9	0.7	2.1
Under 1	747	79.9	16.2	2.3	1.3	—	0.3	—	0.4
1-4	2,890	30.5	39.2	20.6	7.8	1.1	0.4	0.2	1.2
5-9	3,541	24.9	27.9	28.8	11.8	4.3	1.3	1.0	2.1
10-14	3,403	28.3	23.3	25.2	13.3	5.2	2.1	2.5	2.6
15-19	2,662	35.2	26.4	21.0	10.4	4.2	1.7	1.0	2.4
20-24	1,987	34.7	28.6	22.4	10.0	2.8	1.0	0.6	2.2
25-29	1,814	31.8	29.7	25.0	9.9	2.2	1.2	—	2.2
30-34	2,099	30.0	31.6	25.0	9.3	2.6	0.8	0.7	2.4
35-44	4,678	33.6	32.0	23.3	8.1	2.3	0.3	0.3	2.0
45-54	3,698	37.7	31.2	20.9	7.0	2.1	0.6	0.5	1.9
55-64	2,841	41.8	31.2	19.4	5.8	1.2	0.2	0.3	1.7
65+	3,237	36.8	31.3	23.5	6.7	1.0	0.4	0.2	1.8

TABLE 3.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF BEEF BY SEX AND AGE, JULY 1962 SURVEY

Sex and age	Number of observations	Amount (ounces)										Mean (ounces)
		None	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17 +	
Male												
All ages	32013	66.7	2.9	8.2	6.1	7.8	2.4	2.5	0.6	1.8	1.0	2.4
Under 1	710	94.7	2.9	1.2	0.4	0.7	0.2	—	—	—	—	0.2
1-4	3070	68.0	12.2	13.3	3.7	1.7	0.7	0.2	0.1	0.1	—	0.9
5-9	3738	65.1	5.0	15.6	7.3	4.6	1.0	0.8	0.2	0.3	—	1.6
10-14	3577	63.4	2.9	11.0	9.1	7.0	2.4	2.2	0.8	0.8	0.4	2.3
15-19	2592	66.0	1.3	6.2	8.5	7.7	3.1	2.8	0.8	2.1	1.5	2.8
20-24	1677	67.3	0.9	5.2	5.5	9.0	3.4	3.3	0.7	2.5	2.3	2.9
25-29	1611	70.6	0.8	3.7	3.6	9.5	2.6	3.0	0.9	2.8	2.4	2.9
30-34	1972	65.0	1.0	4.2	5.7	10.8	3.1	3.9	1.2	3.3	1.9	3.2
35-44	4247	64.8	1.1	5.9	6.3	9.8	3.1	3.9	0.8	2.5	1.8	3.1
45-54	3568	65.6	0.9	5.5	6.1	9.9	2.9	3.9	0.7	3.1	1.4	3.0
55-64	2589	66.6	1.3	6.2	4.8	10.5	3.5	3.2	0.5	2.5	1.1	2.8
65 +	2662	68.9	1.5	8.1	5.6	9.0	2.2	2.4	0.3	1.7	0.3	2.3
Female												
All ages	33573	67.4	3.7	11.6	6.8	6.3	1.4	1.1	0.3	0.9	0.3	1.9
Under 1	743	94.4	3.1	1.3	0.7	0.5	—	—	—	—	—	0.2
1-4	2891	68.3	12.9	13.5	3.6	1.1	0.4	—	—	—	—	0.7
5-9	3537	66.0	6.2	17.0	5.8	3.0	1.1	0.6	0.2	0.1	—	1.1
10-14	3391	67.7	2.7	12.5	8.4	5.2	1.5	1.2	0.2	0.4	0.2	1.6
15-19	2665	67.7	2.8	10.1	7.6	7.2	1.8	1.1	0.4	1.2	0.2	2.0
20-24	1985	66.9	1.6	10.1	8.2	7.1	1.9	2.2	0.2	1.3	0.4	2.2
25-29	1812	67.5	1.9	9.1	7.9	7.8	1.9	2.0	0.4	0.9	0.4	2.2
30-34	2097	65.2	2.0	10.9	8.1	7.6	1.8	2.0	0.4	1.3	0.6	2.4
35-44	4673	64.1	2.5	11.5	8.1	8.1	1.9	1.7	0.5	1.2	0.4	2.3
45-54	3695	64.3	2.0	10.3	8.0	8.9	1.9	2.3	0.4	1.4	0.4	2.5
55-64	2842	70.1	1.7	10.7	5.3	8.4	1.4	0.9	0.4	1.0	0.1	1.9
65 +	3241	68.5	3.2	12.1	6.1	7.0	0.8	1.0	0.1	0.9	0.2	1.9

TABLE 4.—PERCENTAGE DISTRIBUTION "AT HOME" DAILY CONSUMPTION OF LETTUCE BY SEX AND AGE, JULY 1962 SURVEY

Sex and age	Number of observations	Amount (ounces)							Mean (ounces)
		None	1	2	3	4	5-8	9 +	
Male									
All ages	32022	72.9	5.7	9.5	3.4	5.7	2.3	0.5	0.8
Under 1	710	98.4	0.4	0.3	0.3	—	0.5	0.2	0.1
1-4	3071	83.3	6.9	5.9	1.8	1.3	0.6	0.2	0.3
5-9	3741	76.5	8.6	9.2	2.6	2.1	0.8	0.3	0.4
10-14	3578	72.8	7.3	10.2	4.1	3.5	2.0	0.3	0.7
15-19	2594	71.3	5.5	11.9	4.7	4.4	1.9	0.3	0.8
20-24	1679	73.7	4.3	8.3	4.6	5.8	2.8	0.5	0.9
25-29	1614	68.8	5.1	9.2	3.3	8.7	4.0	0.8	1.1
30-34	1975	67.3	4.8	11.3	3.9	8.9	3.3	0.6	1.1
35-44	4241	66.9	6.1	10.8	3.9	8.8	3.2	0.4	1.0
45-54	3569	69.0	5.1	10.7	3.8	8.1	2.6	0.7	1.0
55-64	2593	70.4	3.8	9.2	3.6	9.1	3.1	0.9	1.0
65 +	2657	74.0	4.2	9.3	2.3	5.9	3.2	1.1	0.9
Female									
All ages	33588	72.1	6.1	10.5	3.2	5.6	2.1	0.4	0.8
Under 1	748	97.8	0.7	0.7	0.3	0.1	0.1	0.3	0.1
1-4	2891	85.0	5.5	6.2	1.6	1.1	0.3	0.2	0.2
5-9	3545	75.8	8.1	19.3	2.8	2.1	0.7	0.1	0.4
10-14	3400	74.2	7.1	10.8	3.1	3.5	1.2	0.1	0.5
15-19	2662	72.0	6.1	10.7	3.8	5.1	2.0	0.2	0.8
20-24	1986	73.6	4.8	9.7	2.8	6.4	2.3	0.4	0.8
25-29	1812	69.4	5.7	10.0	3.3	8.5	2.5	0.7	0.9
30-34	2096	65.5	6.7	13.1	3.4	8.0	3.1	0.2	1.0
35-44	4672	65.8	6.8	12.5	4.9	6.9	2.5	0.6	1.0
45-54	3695	65.0	6.1	12.4	3.4	9.0	3.4	0.8	1.1
55-64	2843	69.8	4.8	10.2	3.2	8.2	2.8	0.9	1.0
65 +	3238	72.8	5.0	11.1	3.1	5.1	2.7	0.3	0.8

TABLE 5.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF APPLES BY SEX AND AGE, JULY 1962 SURVEY

Sex and age	Number of observations	Amount (units)					Mean (units)
		None	1	2	3	4+	
Male							
All ages	32009	93.7	4.0	1.3	0.5	0.6	0.1
Under 1	712	98.7	1.2	0.1	—	—	—
1–4	3062	91.6	6.0	1.5	0.5	0.4	0.1
5–9	3735	91.7	6.1	1.3	0.6	0.3	0.1
10–14	3575	93.9	4.0	1.3	0.3	0.5	0.1
15–19	2597	93.7	2.9	1.4	0.7	1.2	0.2
20–24	1679	94.9	2.8	1.4	0.4	0.4	0.1
25–29	1611	94.1	3.3	1.5	0.8	0.3	0.1
30–34	1974	94.7	3.4	1.0	0.6	0.4	0.1
35–44	4241	95.1	3.1	1.1	0.3	0.5	0.1
45–54	3570	94.2	3.8	0.9	0.4	0.7	0.1
55–64	2597	93.0	3.5	2.0	0.5	1.1	0.1
65+	2656	93.6	3.7	1.4	0.5	0.7	0.1
Female							
All ages	33589	93.5	4.1	1.2	0.5	0.7	0.1
Under 1	743	97.2	2.6	0.1	—	—	—
1–4	2895	90.7	7.1	1.4	0.5	0.3	0.1
5–9	3548	92.4	5.0	1.8	0.4	0.3	0.1
10–14	3492	91.2	5.2	1.3	0.9	1.4	0.2
15–19	2662	94.3	3.1	1.2	0.5	0.9	0.2
20–24	1987	94.8	3.7	0.8	0.1	0.6	0.1
25–29	1813	95.3	3.1	1.1	0.2	0.4	0.1
30–34	2100	95.7	2.9	0.7	0.4	0.4	0.1
35–44	4673	95.0	3.1	1.0	0.3	0.5	0.1
45–54	3698	94.5	3.6	1.3	0.7	0.5	0.1
55–64	2844	92.7	4.1	1.4	0.6	1.2	0.1
65+	3234	92.5	4.2	1.7	0.4	1.2	0.1

TABLE 6.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF WHOLE MILK BY SEX AND REGION, JULY 1962

Sex and region	Number of observations	Amount (fluid ounces)												Mean (fluid ounces)
		None	1–3	4–7	8–11	12–15	16–19	20–23	24–27	28–31	32–35	36–39	40+	
Male														
NE	7,580	21.7	8.3	8.6	12.7	5.7	10.4	4.0	9.4	3.3	9.0	1.5	5.4	14.4
NC	9,006	27.8	6.0	9.0	10.5	7.4	10.0	5.0	7.6	4.0	6.1	1.6	5.0	13.3
S	10,501	42.4	5.0	6.7	12.3	5.1	9.0	3.3	6.2	1.6	5.2	0.7	2.4	9.5
W	4,925	34.8	2.2	6.7	10.5	5.7	11.2	4.8	7.8	1.9	8.1	1.5	4.8	12.9
Female														
NE	8,154	26.0	10.3	11.6	13.1	7.3	9.9	3.6	7.4	2.0	6.1	0.9	1.8	10.8
NC	9,613	34.9	7.0	11.3	12.9	7.1	8.8	4.4	5.2	2.0	3.5	0.8	2.1	9.4
S	10,930	48.0	5.4	8.1	13.7	4.8	7.9	2.3	4.3	1.1	3.0	0.3	0.9	6.9
W	4,871	42.1	3.7	8.3	12.2	6.2	10.1	3.3	6.4	1.0	4.2	0.6	1.8	8.9

TABLE 7.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF WHITE BREAD BY SEX AND REGION, JULY 1962 SURVEY

Sex and region	Number of observations	Amount (slices)							Mean (slices)
		None	1, 2	3, 4	5, 6	7, 8	9, 10	11+	
Male									
NE	7,585	29.1	22.1	21.0	13.4	6.6	3.9	3.8	3.3
NC	9,010	26.7	23.2	22.2	14.9	6.8	3.4	2.8	3.3
S	10,520	34.4	19.5	20.4	12.9	6.7	3.2	2.8	3.0
W	4,927	36.1	20.8	21.0	12.9	5.3	2.5	1.4	2.7
Female									
NE	8,154	31.4	28.3	25.1	10.2	3.1	1.0	1.1	2.4
NC	9,618	31.4	32.9	23.6	8.4	2.6	0.7	0.4	2.1
S	10,955	36.7	28.7	21.3	9.1	2.6	1.0	0.6	2.1
W	4,870	39.6	29.7	20.0	7.1	2.2	0.7	0.8	1.9

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TABLE 8.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF BEEF BY SEX AND REGION, JULY 1962 SURVEY

Sex and region	Number of observations	Amount (ounces)										Mean (ounces)
		None	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17+	
Male												
NE	7,590	64.6	2.7	8.8	5.5	9.0	2.2	3.2	0.8	1.8	1.3	2.7
NC	8,999	64.5	3.1	8.6	7.1	7.9	2.8	2.3	0.5	2.0	1.3	2.6
S	10,509	73.7	2.6	6.9	5.1	5.8	2.0	1.8	0.4	1.1	0.5	1.9
W	4,915	60.0	3.3	9.1	7.4	9.5	2.9	3.4	0.7	2.5	1.3	3.0
Female												
NE	8,166	65.6	3.0	11.7	6.9	7.6	1.6	1.8	0.4	0.9	0.4	2.2
NC	9,603	65.5	4.1	12.1	7.4	6.5	1.5	1.3	0.3	1.0	0.2	2.0
S	10,948	73.5	3.6	10.0	5.4	4.5	1.3	0.8	0.1	0.6	0.2	1.5
W	4,856	60.7	4.2	13.6	8.5	7.7	1.6	1.6	0.4	1.1	0.4	2.4

TABLE 9.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF LETTUCE BY SEX AND REGION, JULY 1962 SURVEY

Sex and region	Number of observations	Amounts (ounces)							Mean (ounces)
		None	1	2	3	4	5-8	9+	
Male									
NE	7,574	67.7	7.0	11.8	3.5	6.8	2.8	0.4	0.9
NC	9,006	72.4	4.9	9.2	4.1	5.4	3.0	1.0	0.9
S	10,514	86.9	4.8	7.4	1.9	3.5	1.2	0.3	0.5
W	4,928	64.8	7.3	10.4	5.2	9.1	2.8	0.3	1.0
Female									
NE	8,155	65.2	7.9	13.9	3.9	6.2	2.6	0.4	1.0
NC	9,614	72.4	5.5	9.8	3.9	5.3	2.5	0.7	0.8
S	10,950	79.9	4.7	8.5	1.8	3.7	1.1	0.2	0.5
W	4,869	65.9	7.0	10.9	4.2	9.3	2.4	0.4	1.0

TABLE 10.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF APPLES BY SEX AND REGION, JULY 1962 SURVEY

Sex and region	Number of observations	Amounts (units)					Mean (units)
		None	1	2	3	4+	
Male							
NE	7,586	93.6	4.7	1.2	0.2	0.3	0.1
NC	8,997	93.3	3.9	1.4	0.7	0.7	0.1
S	10,500	93.8	3.3	1.6	0.5	0.8	0.1
W	4,926	94.3	4.4	0.8	0.3	0.1	0.1
Female							
NE	8,158	93.9	4.5	1.0	0.2	0.3	0.1
NC	9,620	93.7	3.9	1.1	0.6	0.8	0.1
S	10,939	92.5	3.9	1.7	0.7	1.2	0.2
W	4,872	94.8	4.1	0.9	0.2	0.1	0.1

Tri-City Diet Study*
June–July 1962

Joseph Rivera
Health and Safety Laboratory, U.S. Atomic Energy Commission

Since May 1960 the Health and Safety Laboratory, through its quarterly diet study, has made estimates of the strontium-90 content of the average diet of individuals living in New York City, San Francisco, and Chicago.

Selected foods, representing 19 food categories, are purchased at each of these three cities about every 3 months and are analyzed for strontium-90. Using data from the U.S. Department of Agriculture, "Household Food Survey of 1955," the annual consumption by an average individual can be grouped into the same 19 food categories. The annual dietary intake of strontium-90 can then be estimated by summing the contributions from each category. Some food types are assumed to be representative of larger food categories, such as liquid milk for dairy products in general.

The consumption data from the "Household Food Survey of 1955" are based on a weight as purchased basis. Before the food samples for the Tri-City Diet Study are ashed for radiochemical analysis, they are prepared to a certain degree as if for actual consumption. For example, fruits are peeled, eggs are shelled, and poultry is de-boned. Therefore, concentrations of radioactivity in foods as reported in the Tri-City Diet Study are based on the trimmed weight. No correction is made for the wasted food.

After two samplings at each city it was found that the calcium content of most food categories did not vary among cities nor did it vary significantly with time. Calcium analyses were, therefore, discontinued and average calcium content of foods was computed and used to estimate the average annual intake of this mineral. The specific numbers used to calculate calcium intake are given in *HASL–113 (1)*.

Results obtained from the ninth sampling of foods (June–July 1962) are presented in table 1. The variation with time of the daily intake of strontium-90 in the three cities is plotted in figure 1.

TABLE 1.—AVERAGE PERSON DIETARY CONSUMPTION AND STRONTIUM-90 INTAKE—NINTH SAMPLING

Food category	Average U.S. consumption		New York City June 1962		Chicago July 1962		San Francisco June 1962	
	Food (kg/yr)	Calcium (g/yr)	μμc/kg	μμc/yr	μμc/kg	μμc/yr	μμc/kg	μμc/yr
Bakery products	37	27.0	7.1	263	16.5	611	5.0	185
Whole grain products	11	10.0	11.0	121	13.0	143	6.8	75
Eggs	16	9.1	0.7	11	—	*38	3.0	48
Vegetables, fresh	43	15.0	12.1	520	3.9	168	3.7	159
Vegetables, root	17	6.1	3.4	58	7.5	128	4.1	70
Milk	221	234.5	9.0	1,989	11.5	2,542	2.4	530
Poultry	17	9.2	3.6	61	7.0	119	2.1	36
Fish, fresh	8	10.8	—	*3	1.3	10	1.6	13
Flour	43	8.6	2.1	90	8.8	378	5.0	215
Macaroni	3	0.7	5.7	17	6.6	20	3.9	12
Rice	3	1.1	1.0	3	1.5	5	1.2	4
Meat	73	10.9	0.8	58	1.1	80	0.8	58
Fish, shell	1	0.8	4.0	4	1.1	1	3.9	4
Beans, dried	3	2.9	5.2	16	10.9	33	4.6	14
Fruit, fresh	68	13.6	3.7	252	3.4	231	2.3	156
Potatoes	45	5.8	8.6	387	1.6	72	2.9	130
Fruit, canned	26	1.3	1.1	29	1.3	34	0.5	13
Juices, fruit	19	1.7	2.7	51	1.1	21	4.0	76
Vegetables, canned	20	4.2	4.8	96	6.8	136	2.1	42
Annual intake	674	383	6.0	4,029	7.1	4,770	2.7	1,840
Strontium-90 to calcium ratio in total diet			10.5		12.5		4.8	

* Estimated from eighth sampling.

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* *Fallout Program Quarterly Summary Report, HASL–132*, 219–223, Office of Technical Services, Department of Commerce, Washington 25, D.C. (January 1, 1963), price $3.50.

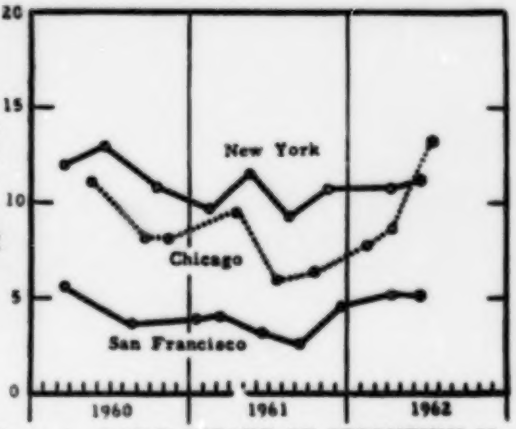

Figure 1.—DAILY INTAKE OF STRONTIUM-90 IN TRI-CITY TOTAL DIETS

Discussion

The greatest difference seen between this sampling and the previous sampling is the sharp increase in the strontium-90 intake at Chicago. This was due principally to the increased strontium-90 levels in milk. Since strontium-89 has a half life of 50 days, the amount of strontium-89 present in a sample relative to a longer-lived nuclide such as strontium-90 is indicative of the age of the fission products. Measurements of strontium-89 in the July Chicago milk sample indicated that much of the strontium-90 in the sample was probably of recent origin.

Chicago during July 1962 had the highest daily intake that has been estimated for any of the cities since the tri-city diet surveys began, and for the first time had a higher strontium-90 intake than that estimated for New York City. It is anticipated, however, that diet levels in New York City will again be found to be higher than those in Chicago in the next sampling, since New York City milk levels have increased significantly since June.

The relative contributions of the 19 dietary components used in the diet surveys to the annual intake of strontium-90 were computed for each city for each of the nine surveys completed so far. Despite the variability found from survey to survey at a given city, the average distribution for the nine surveys at each of the cities was remarkably similar.

These average values and the average value of all three cities combined are shown in table 2. The data in the table suggest that for periods of fallout similar to that experienced in 1960, 1961, and early 1962, good estimates of the Sr^{90}/Ca ratio in the total diet can be made by measuring the strontium-90 and calcium content of only a few foods. If, for example, milk, bakery products, fresh fruits and vegetables, flour, meat, and whole grain products were sampled periodically, they would account for about 75 percent of the strontium-90 and calcium taken in during the year.

TABLE 2.—PERCENTAGE OF TOTAL STRONTIUM-90 INTAKE AND PERCENTAGE OF THE TOTAL CALCIUM INTAKE CONTRIBUTED BY VARIOUS DIETARY COMPONENTS

[Average of 9 samplings, 1960–1962]

Dietary component	Percentage of total Sr^{90} intake				Percentage of total Ca intake
	New York City	Chicago	San Francisco	Tri-city average	Tri-city average[1]
Bakery products	7	10	10	9	9.6
Whole grain products	4	5	5	5	2.6
Eggs	1	1	2	1	2.4
Vegetables, fresh	10	10	7	9	3.9
Vegetables, root	3	3	4	3	1.6
Milk	47	39	37	41	61.1
Poultry	1	1	1	1	2.4
Fish, fresh	0	0	0	0	2.8
Flour	6	10	8	8	2.2
Macaroni	0	0	1	0	0.2
Rice	0	0	0	0	0.3
Meat	1	2	3	2	2.8
Fish, shell	0	0	0	0	0.2
Beans, dried	1	1	1	1	0.7
Fruit, fresh	8	7	7	7	3.5
Potatoes	6	4	6	5	1.5
Fruit, canned	1	1	2	1	0.3
Juices, fruit	1	2	3	2	0.4
Vegetables, canned	2	3	2	2	1.1

[1] See reference 2.

Strontium–90 and Calcium in United States Wheat*
1958–1961

Joseph Rivera
Health and Safety Laboratory, Atomic Energy Commission

The contamination of United States wheat crops by strontium–90 has been studied extensively by the Health and Safety Laboratory since 1958. The latest data available in this continuing study are the strontium–90 and calcium concentrations found in wheat harvested in 1961. These data, along with the results obtained from analyses of the 1958, 1959, and 1960 crops, are presented in table 1.

It is apparent from the data presented that there has been no appreciable change in the concentrations of strontium–90 found in the 1961 crop as compared to those found in 1960. The production weighted average (*1*) strontium–90 concentration for the 1961 crop was 23 ± 10 $\mu\mu c$/kg as compared to 24 ± 9 $\mu\mu c$/kg observed in 1960. The average Sr^{90}/Ca ratio was 72 ± 36 strontium units in 1961 as compared to 62 ± 23 strontium units found in 1960.

These investigations are being carried out primarily to add to the understanding of the mechanism of contamination of wheat by strontium–90. As was pointed out previously (*2*), the origin of the strontium in wheat is either the soil or direct deposition on the aerial parts of the plant. An empirical formula has been deduced to express the average contamination of the U.S. wheat crop in terms of the average deposition rate of strontium–90 in June (the principal harvest month) and the estimated cumulative deposit of strontium–90 in the midwest soils. The formula is:

$$V = 0.1\,S + 100\,R,$$

where V is $\mu\mu c$ Sr^{90}/g Ca in wheat, S is mc Sr^{90}/mi^2 in soil, and R is mc Sr^{90}/mi^2 deposited in June.

The coefficients of S and R were chosen to fit the data obtained in 1958, 1959, and 1960, but *not* in 1961. The usefulness of the formula depends on how accurately the average Sr^{90}/Ca ratio in wheat can be predicted when S and R are known. Data in table 2 show predicted and observed values of V for 1958 through 1962.

The agreement of the observed with the predicted result for the 1961 wheat crop is gratifying. It will be interesting to see if the predicted value for 1962 agrees with what will be found in this crop, since the observed fallout rate is considerably higher than any previously experienced in June.

TABLE 1.—COMPARISON BETWEEN STRONTIUM-90 AND CALCIUM LEVELS IN UNITED STATES WHEAT SAMPLED IN 1958, 1959, 1960, AND 1961

State	g Ca/kg				$\mu\mu c$ Sr^{90}/kg				$\mu\mu c$ Sr^{90}/g Ca			
	1958	1959	1960	1961	1958	1959	1960	1961	1958	1959	1960	1961
California	[a] —	0.31	0.33	0.30	—	17	3.7	3.4	—	49 [b] (2)	11 (5)	11 (2)
Colorado	—	0.49	0.42	0.36	—	46	19	27	—	71 (5)	46 (2)	74 (1)
Idaho	—	0.34	0.35	0.36	—	5.7	6.1	4.6	—	17 (1)	18 (2)	12 (1)
Illinois	0.40	0.38	—	—	133	51	—	—	330 (1)	142 (1)	—	—
Iowa	—	0.54	0.38	0.43	—	62	34	25	—	109 (2)	80 (1)	58 (1)
Kansas	0.36	0.49	0.42	0.28	82	47	26	34	227 (1)	97 (1)	62 (1)	124 (1)
Michigan	0.36	0.38	—	—	42	18	—	—	118 (1)	125 (1)	—	—
Minnesota	0.35	0.35	—	—	51	59	—	—	162 (16)	181 (2)	—	—
Missouri	—	0.43	0.42	0.28	—	121	21	19	—	272 (4)	50 (1)	68 (1)
Montana	0.47	0.38	0.40	0.33	59	20	15	26	125 (1)	52 (1)	38 (1)	80 (1)
Nebraska	—	0.38	0.37	0.32	—	76	32	21	—	150 (3)	68 (3)	61 (4)
New York	0.36	0.37	0.41	0.31	44	44	16	25	121 (1)	119 (1)	40 (1)	81 (1)
North Dakota	0.31	0.33	0.29	0.33	40	51	26	13	134 (10)	154 (1)	91 (1)	40 (1)
Ohio	—	0.36	0.18	0.34	—	56	35	26	—	152 (11)	73 (4)	78 (1)
Oklahoma	0.35	0.40	0.39	0.40	34	63	35	24	82 (1)	159 (1)	90 (2)	60 (1)
South Dakota	0.35	—	—	—	61	—	—	—	171 (8)	—	—	—
Texas	0.44	0.51	—	0.40	44	51	—	14	99 (2)	99 (1)	—	34 (1)
Utah	—	0.48	0.44	0.39	—	21	7.9	3.0	—	45 (5)	19 (4)	8 (1)
Washington	—	0.32	0.35	0.38	—	9.2	7.0	7.4	—	30 (2)	20 (1)	20 (1)

[a] Dash indicates no sample.
[b] Numbers in parentheses are the number of samples.

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* Data from *Fallout Program Quarterly Summary Report, HASL–132*: 224–7, Office of Technical Services, Department of Commerce, Washington 25, D.C. (January 1, 1963), price $3.50.

REFERENCES

(*1*) Hansen, Harry (Ed.): *The World Almanac 1962 and Book of Facts*, New York World Telegram Corporation, New York (1962), p. 665.

(*2*) Rivera, J.: Strontium-90 Levels in U.S. Wheat and Milling Products through 1960, *Fallout Program Quarterly Summary Report, HASL-122*, 188–92, Office of Technical Services, Department of Commerce, Washington 25, D.C. (April 1, 1962), Price $3.00.

TABLE 2.—STRONTIUM-90 ACTIVITY IN U. S. SOIL AND WHEAT

Harvest year	Soil activity[1] (S) mc Sr^{90}/mi^2	June deposition rate[2] (R) mc Sr^{90}/mi^2	$\mu\mu c$ Sr^{90}/g Ca in wheat	
			Predicted (V)	Observed
1958	46	1.49	154	172
1959	66	1.45	152	147
1960	70	0.48	55	62
1961	74	0.62	69	72
1962	[3] (88)	[3] (3.22)	331	—

[1] Estimated from cumulative soil strontium-90 measurements and integrated monthly fallout collections.

[2] Estimated from monthly fallout collections in approximately 10 States.

[3] Estimated from preliminary data obtained for June deposition.

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For purposes of comparison with findings in the United States concerning strontium-90 in diet, the following summary presents corresponding information from the United Kingdom. Conclusions drawn from direct comparisons between the radionuclide contents of the same food items for each country should be qualified. For example, about a third of the United Kingdom's meat supplies are imported from the Southern Hemisphere where fallout is lower.

Strontium–90 in Diet in the United Kingdom[1]

1958–1961

Agricultural Research Council Radiobiological Laboratory

Responsibility for the investigation of the contamination of human food with radioactive substances in the United Kingdom was assigned in 1957 to the Agricultural Research Council (ARC). In 1958, when surveys of radioactivity in human diet were begun in the ARC Radiobiological Laboratory (ARCRL), attention was confined to strontium–90 as this is the long-lived component of world-wide fallout which delivers the highest radiation doses to man through the contamination of his food. Some measurements of the shorter-lived isotope, strontium–89, were also made, but their primary purpose was to provide information on the mechanisms by which strontium–90 enters the diet. The sampling network devised for strontium–90 later provided a basis for measurements of iodine–131, barium–140, and cesium–137.

Basis of Investigations

In any investigation of strontium-90 in the human diet the ultimate objective is to estimate the radiation dose which the skeleton will receive. This depends on the distribution and concentration of strontium–90 in the skeleton, that is to say, on the quantity of strontium–90 laid down per unit weight of new bone. Because strontium and calcium are transferred from the diet to bone in a relatively constant ratio, calicum effectively dilutes the strontium–90 in the skeleton and the resultant dose is determined by *the ratio of strontium–90 to calcium in the total diet* and not by its content of strontium–90 alone. It is, therefore, most important to determine this ratio, which is conventionally expressed in terms of picocuries (pc) of strontium–90 per gram of calcium. However, when the ratio is calculated for foods which contribute only a small fraction of the total calcium in diet, it provides no indication of the effective dose of radiation to the skeleton; if, for example, the ratio of strontium–90 to calcium were 100 in an article of diet which provides only 1 percent of the total calcium in diet, the strontium–90 in that food would lead to a ratio of strontium–90 to calcium of only 1 in the total diet. Accordingly, when individual articles of diet are investigated, the objective must be to determine the quantities of both strontium–90 and calcium which they provide to the total diet so that the total quantity of each can be calculated, and the appropriate ratio for the whole diet determined.

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[1] Summarized from the following reports:

Agricultural Research Council Radiobiological Laboratory: *Strontium–90 in Human Diet in the United Kingdom, ARCRL–1*, Her Majesty's Stationery Office, London (1958), price 4s.

Agricultural Research Council Radiobiological Laboratory: *Strontium–90 in Human Diet in the United Kingdom, ARCRL–3*, Her Majesty's Stationery Office, London (1959), price 3s. 6d.

Agricultural Research Council Radiobiological Laboratory: *Interim Report on Radioactivity in Diet, ARCRL–5*, Her Majesty's Stationery Office, London (May 1962), price 2s. 0d.

Agricultural Research Council Radiobiological Laboratory: *Annual Report 1961–62, ARCRL–8*, Her Majesty's Stationery Office, London (September 1962), price 6s. 6d.

Standards

The Medical Research Council has recommended that the maximum permissible levels of strontium–90 in bone for the population as a whole and for individual members of it are 67 and 200 pc/g Ca respectively. In deriving the levels of strontium–90 which are acceptable in articles of diet it has been taken into account, *firstly*, that the Medical Research Council recommended that the situation should be reassessed if the level of strontium–90 in the bones of any age group of the general population reached half the maximum permissible level, and, *secondly*, that the ratio of strontium–90 to calcium in the newly formed bone of adults will be about one quarter of that in diet though a high fraction may operate for a time in the very young. On this basis, the following working levels can be derived for assessing the results of surveys of strontium–90 in human diet:

For individuals in the general population: 400 pc Sr^{90}/g Ca.

Average for the population as a whole: 130 pc Sr^{90}/g Ca.

These working levels refer to the average content of the diet over a year. They should not be confused with maximum permissible levels. If continued indefinitely, exposure to the working level would cause approximately half the maximum permissible levels in the bone of the population as a whole.

Sampling Results

When the ARC's sampling program for strontium–90 in the diet began it was necessary to limit the total number of assays to approximately 300 per annum, though some increase in the number later became possible. This number was dictated by the laborious operations which are necessary to separate radioactive strontium from other radioactive materials. To obtain the maximum information in the face of this limitation, it has been necessary to devise elaborate sample collecting schemes so that all samples assayed are truly representative.

TABLE 1.—CALCULATION OF THE MEAN CONTENT OF STRONTIUM–90 IN HUMAN DIET IN THE UNITED KINGDOM, 1958–1961[1]

Food	Calcium[2] Mean daily intake[3] (grams)	1958		1959		1960		1961	
		Mean ratio[3] (pc Sr^{90}/g Ca)	Est. daily intake (pc)	Mean ratio[3] (pc Sr/^{90}g Ca)	Est. daily intake (pc)	Mean ratio[3] (pc Sr^{90}/g Ca)	Est. daily intake (pc)	Mean ratio[3] (pc Sr^{90}/g Ca)	Est. daily intake (pc)
Dairy produce									
Milk and cream	0.496	7.0	3.47	9.8	4.86	6.4	3.17	5.9	2.93
Cheese	0.095	7.7	0.73	7.5	0.71	5.3	0.50	4.8	0.46
Vegetables & Fruit									
Root vegetables	0.025	14.2	0.35	23.2	0.58	19.6	0.49	24.3	0.61
Leaf & other vegetables	0.038	8.7	0.33	14.3	0.54	8.5	0.32	10.3	0.39
Fruit, etc	0.024	8.7	0.21	14.3	0.34	8.5	0.20	10.3	0.25
Flour & cereal all types	0.047	15.9	0.75	28.0	1.32	22.7	1.07	21.8	1.02
Other animal produce									
Eggs	0.019	2	0.04	9.0	0.17	6.3	0.12	6.3	0.12
Meat	0.019	14	0.27	19.6	0.37	12.8	0.24	11.8	0.22
Fish	0.014	<1	<0.01	<1	<0.01	<1	<0.01	<1	<0.01
Other sources	0.004	—	—	—	—	—	—	—	—
Total in food	0.78	7.9	6.16	11.4	8.90	7.8	6.12	7.7	6.01
Creta praeparata (mineral calcium)	0.243	—	—	—	—	—	—	—	—
Total in foodstuffs	1.024	6.0	6.16	8.7	8.90	6.0	6.12	5.9	6.01
Drinking water	0.060	—	0.23	—	0.43	—	0.36	—	0.25
Tea	—	—	—	—	0.45	—	0.45	—	<0.45
Total	1.084	5.9	6.39	9.0	9.78	6.4	6.93	6.2	6.71

[1] Adapted from Table 13, p. 22, ARCRL: *Annual Report 1961–2, ARCRL–8.*
[2] Ministry of Agriculture, Fisheries and Food: *Domestic Food Consumption and Expenditures, 1958,* H.M.S.O., London (1960).
[3] For details of calculations see Agricultural Research Council Radiobiological Laboratory, Reports *ARCRL 1, 3, 5, 8.*

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The manner in which milk distribution in the United Kingdom is organized made it possible to apply a detailed statistical sampling scheme to obtain representative samples. On two days in every month samples representative of a day's throughput are collected at over 200 depots, which handle more than 40 percent of the country's total production. The milk is combined, in proportion to the production of the depots, to give duplicate samples from each of ten zones. Analyses are made on bulked produce from either three or six collections. This scheme enables the sampling and analytical error to be estimated.

Table 1 summarizes the results of the ARC human diet sampling program for the period 1958–1961. Mean daily intake of calcium in various foods and the measured annual average ratios of strontium–90 to calcium are shown, together with the daily intake of strontium–90 calculated from these values.

Table 1 is divided horizontally into three parts. The first section contains the data for the five food categories—dairy products, vegetables and fruits, flour and cereal, other animal products, and other sources—together with the total (total in food) from these items. The second section contains the contributions of *creta praeparata** and the total (total in foodstuffs) obtained by combining the contribution due to *creta praeparata* to the total in food mentioned above. The last section includes the data for water and tea along with the total (total) secured by combining the contribution of these beverages to the total in foodstuffs.

Table 2 shows a comparison of the ratios of strontium–90 to calcium in milk and in all foods for the same period.

TABLE 2.—COMPARISON OF RATIOS OF STRONTIUM-90 TO CALCIUM IN MILK AND ALL FOODS, 1958–1961

Year	Ratio: Sr^{90}/Ca (pc/g)		Ratio: Sr^{90}/Ca in milk / Sr^{90}/Ca in all foods[1]
	Milk	All Foods[1]	
1958	7.0	6.0	1.16
1958	9.8	8.7	1.12
1960	6.4	6.0	1.07
1961	5.9	5.9	1.00

[1] Excluding drinking water and tea.

Discussion

The ratios of strontium–90 to calcium in dairy produce were similar to the mean ratio in the total average diet (table 2). Variations in the quantities of these foods which are consumed would therefore have had little effect on the average ratio of strontium–90 to calcium in the total diet. The erroneous conclusion has sometimes been drawn that because milk contributes a large part of the total strontium–90 in the diet its exclusion from a mixed diet would reduce the level of strontium–90 in bone. Indeed, under some circumstances the reverse may be true, since if certain diets included abnormally large quantities of foods containing higher ratios of strontium–90 to calcium, such as cereals to which no *creta praeparata* has been added, an increased consumption of milk could reduce appreciably the mean ratio of strontium–90 to calcium in the diet.

The ratio of strontium–90 to calcium in vegetables and fruit considerably exceeded that in the average diet of the population; abnormally large consumption of these foods would, however, have had only a small effect on the average content in the diet because of their relatively small contribution to the total intake of calcium. For example, in 1961, if the daily intake of root vegetables in an otherwise average diet had been doubled, the ratio of strontium–90 to calcium would have been increased by less than 7 percent. Doubling the intake of leaf vegetables, fruit, or meat would have had a smaller effect. A larger change would occur if white bread were replaced by bread made from unfortified wholemeal flour. It appears that this change in 1961 might have caused the ratio of strontium–90 to calcium in the total diet to be increased from 6.2 to about 10.6 pc/g. Such an increment cannot, however, be regarded as representative of the situation for any large section of the population, since wholemeal flour which contains no *creta praeparata* appears to amount to not more than 0.05 percent of the total flour supplies of the United Kingdom and many users of this product consume also flour to which *creta praeparata* has been added.

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* *Creta praeparata* is mineral calcium which is compulsorily added to white flour. This addition is not necessarily done with wholemeal flour.

In addition to food and water, inhalation makes a contribution to the total intake of strontium-90. It has been estimated that in 1959 inhalation accounted for less than 4 percent of the total intake. The rate of fallout in 1961 was less than half of that in 1959, while the dietary intake was some 70 percent of that in the earlier year. Thus, the relative contribution of inhalation during 1961 may be assumed to have been still smaller.

Between 1958 and 1960 there was a slow but steady decrease in the relative contribution of dairy product to the total intake of strontium-90 in food and a corresponding increase in the relative contributions of vegetables and cereals. This trend continued in 1961. Dairy produce accounted for 56 percent of the total in food as compared with 60 percent in 1960, the relative contribution of vegetables increased from 17 to 21 percent, and that of cereals (17 percent) remained the same as in the previous year.

This situation is compatible with the fallout conditions during 1961. During that part of the year when cattle were grazing and when most vegetables and cereals were being grown, the rate of fallout was lower in 1961 than in any of the previous three years. When the rate of fallout is high the efficient retention of material by pastures and its uptake by foliar and plant-base absorption can, to a considerable extent, offset the effect of the discrimination which occurs in the passage of strontium and calcium from the diet of cattle to their milk; thus the ratio of strontium-90 to calcium in milk can be much higher, relative to those in vegetables and cereals, than it would be if strontium-90 were entering from the soil. When the rate of fallout is low and most of the strontium-90 in the diet is entering by absorption from the soil, the effect of this discrimination becomes more marked, although for some time it may be partially offset by continued uptake of strontium-90, undiluted with calcium, by plant-base absorption from the surface "mat" which characterizes many pastures.

Summary

In 1958 the estimated mean strontium-90 to calcium ratio in the average diet for the whole population in the United Kingdom was 5.9 pc/g.

It is estimated that the mean ratio of strontium-90 to calcium in the average diet of the whole population in the United Kingdom during 1959 was 9.0 pc/g and that it did not exceed 15 pc/g in the diet of any large section of the population. Because of the relatively high levels of contamination early in the year these values are about 50 percent higher than those estimated for 1958. The estimated level in the diet of the population as a whole, however, represents less than one-tenth of the working level derived from the recommendations of the Medical Research Council.

During 1960, the strontium-90 to calcium in the diet had dropped to 6.4 pc/g.

The ratio of strontium-90 to calcium in the total diet in 1961 was 6.2 pc/g, a value similar to that for 1960. The ratio of strontium-90 to calcium in infant diets for 1961 was 5.9 pc/g, if it is assumed that milk was their sole diet.

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SECTION III.—MILK

Milk Surveillance

Though milk is only one of the many sources of dietary intake of radionuclides, it is the single food item most often used as an indicator of the population's intake of radionuclides from the enviroment. This is because milk is a basic constituent of the diet of a substantial proportion of the U.S. population and contains most of the radionuclides identified as being biologically important. In addition, milk is produced and consumed on a regular basis, is convenient to handle, is easily analyzed, and samples which are representative of milk consumption in any area can be readily obtained.

PASTEURIZED MILK NETWORK
November 1962

Division of Radiological Health and Division of Environmental Engineering and Food Protection, Public Health Service

In 1957 the Public Health Service began analyzing raw milk to determine relationships between dairy practices and radionuclide levels in milk. However, it became evident that the milk actually consumed by the population should be included in a broader sampling program. In 1960 the pasteurized milk network was initiated to provide data representative of the milk consumed in selected municipalties. Both raw and pasteurized milk sampling data were reported concurrently until June 1961 to premit comparison of the differences between the earlier, limited, milkshed sampling results and those exhibited in pasteurized milk monitoring. Since June 1961, raw milk sampling has been carried out for investigative rather than monitoring purposes.

During November 1962, pasteurized milk surveillance was conducted at 62 Pasteurized Milk Network stations with the cooperation of State and local milk sanitation agencies which have been shipping samples to the PHS Southwestern, Southeastern, and Northeastern Radiological Health Laboratories for analysis. Publication in *Radiological Health Data* follows 3 to 4 months after sample collection because of the time required for shipment, processing, radioanalysis of strontium, data compilation, and publication procedures. Data from gamma analyses (iodine-131) are available to State public health officials and the Federal Radiation Council within 3 days after sample collection for possible countermeasure purposes.

Sampling and Compositing Procedures

The current program emphasizes (1) measurement of the concentrations of radioactivity in samples of pasteurized milk consumed by the public in various regions of the country, and (2) provision of at least one sampling point within all States; additional points are sampled when indicated by widely varying conditions of the milk supply or when needed in order to cover large population groups. Each sample is composited from subsamples collected from each plant in proportion to the relative volumes of milk sold. The objective of this sampling program is to reflect about 90 percent of each city's milk supply. Prior to September 15, 1961, the composite sample was taken from one day's sales per month and was as representative of a community's total supply as could be achieved under practical conditions. Since the resumption of nuclear weapons testing, the sampling frequency has been increased. During November 1962, most stations were sampled twice a week. All surveillance data are subject to continuing review and evaluation to observe unusual patterns or concentrations which may require immediate attention. Further atmospheric nuclear testing may require re-evluation and adjustment of the sampling frequency and analytical schedule for this program.

Iodine–131, cesium–137, and barium–140 are determined by gamma scintillation spectroscopy,[1] while strontium–89 and strontium–90 are determined by radiochemical procedures. The minium detectable concentrations in units of μμc/liter are: Sr^{89}, 5; Sr^{90}, 1; I^{131}, 10; Cs^{137}, 5; and Ba^{140}, 10.

Table 1 presents summaries of all available analyses for November 1962. When a radionuclide is reported by a laboratory as being below the minimum detectable concentration, one-half of this value is used in calculating the monthly average. A similar procedure is used for the network average.

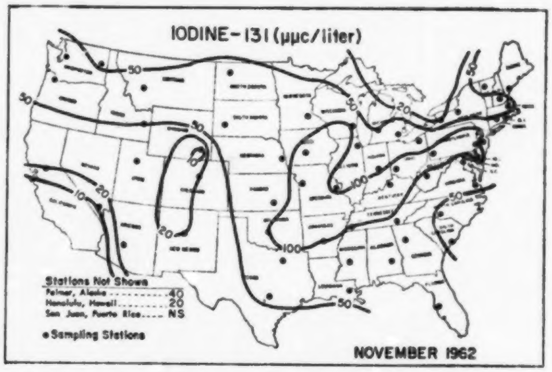

Figure 1.—IODINE–131 CONCENTRATIONS IN PASTEURIZED MILK

Discussion of the Data

The November 1962 monthly average iodine–131 concentrations in milk ranged from 10 to 170 μμc/liter. Most of the country had values between 50 and 100 μμc/liter, while the Southwest reported values below 50 μμc/liter (see figure 1). A ridge of high iodine–131 concentration (> 100 μμc/liter) extended from Pennsylvania to Oklahoma and from Oklahoma to Wisconsin. Measured concentrations in Palmer, Alaska decreased from 270 to 40 μμc/liter from October to November.

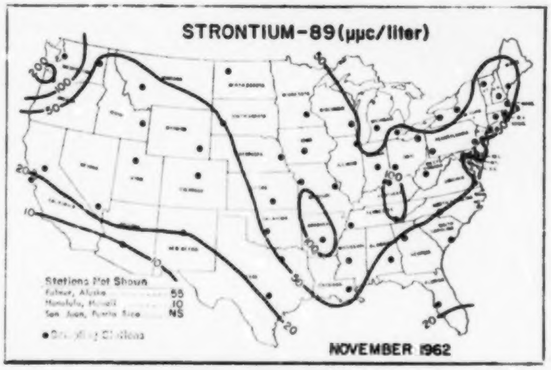

Figure 2.—STRONTIUM–89 CONCENTRATIONS IN PASTEURIZED MILK

The great majority of stations had strontium–89 November monthly average concentrations in milk of 20 to 70 μμc/liter, the western portion of the nation reporting the lower values (see figure 2). Three areas, eastern Kentucky-Tennessee, Missouri-Arkansas, and western Oregon-Washington, had monthly average concentrations greater than 100 μμc/liter. Portland, Oregon, averaged the highest (200 μμc/liter) strontium–89 concentration in milk for November. The Palmer, Alaska monthly average decreased from 150 to 55 μμc/liter from October to November. This station had relatively large strontium–89 and iodine–131 concentrations in milk compared to the continental U.S. during September and October 1962 (reported in previous issues of *RHD*), indicating that large amounts of fission products were being deposited there.

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[1] Southeastern Radiological Health Laboratory employs a radiochemical procedure for barium–140 analysis.

TABLE 1.—RADIOACTIVITY IN PASTEURIZED MILK, NOVEMBER 1962

[Average radioactivity concentrations in μμc/liter]

Sampling locations		Calcium (g/liter)		Strontium-89		Strontium-90		Iodine-131		Cesium-137		Barium-140	
		Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month
Ala:	Montgomery	1.22	1.28	35	40	13	17	10	70	35	35	10	20
Alaska:	Palmer	1.08	1.32	75	55	12	12	250	40	55	60	30	10
Ariz:	Phoenix	1.08	1.34	10	10	2	4	10	30	15	15	10	10
Ark:	Little Rock	1.21	1.28	80	110	29	28	10	100	55	65	20	30
Calif:	Sacramento	1.11	1.31	5	30	3	4	20	20	20	25	20	10
	San Francisco	1.13	1.37	10	15	4	4	20	10	20	20	20	<10
Colo:	Denver	1.11	1.25	55	25	15	8	30	20	75	50	10	<10
Conn:	Hartford	1.10	1.13	30	50	12	14	30	50	70	70	<10	10
Del:	Wilmington	1.09	1.08	40	70	13	16	30	140	70	70	<10	30
D. C:	Washington	1.16	1.22	45	50	17	18	20	80	60	60	10	20
Fla:	Tampa	1.23	1.26	20	30	11	11	<10	80	145	140	<10	10
Ga:	Atlanta	1.23	1.25	45	45	19	15	20	80	55	50	10	20
Hawaii:	Honolulu	1.07	1.26	10	10	4	5	10	20	35	40	<10	<10
Idaho:	Idaho Falls	1.09	1.29	45	25	11	12	40	50	75	70	20	10
Ill:	Chicago	1.14	1.12	35	50	14	13	50	60	60	65	<10	<10
Ind:	Indianapolis	1.11	1.16	40	55	16	14	30	90	40	55	<10	10
Iowa:	Des Moines	1.10	1.40	80	70	14	11	60	120	40	50	20	20
Kans:	Wichita	1.12	1.35	60	55	13	11	40	80	40	35	10	20
Ky:	Louisville	1.19	1.24	75	120	22	25	20	130	35	50	20	40
La:	New Orleans	1.22	1.29	75	65	30	20	10	60	80	55	20	20
Maine:	Portland	1.15	1.15	45	65	15	16	30	70	120	115	<10	20
Md:	Baltimore	1.16	1.24	40	45	18	17	20	80	60	60	<10	20
Mass:	Boston	1.12	1.10	45	60	21	20	30	40	125	110	10	20
Mich:	Detroit	1.10	1.14	35	60	12	19	50	80	70	70	<10	20
	Grand Rapids	1.15	1.20	35	40	10	15	40	50	60	70	<10	10
Minn:	Minneapolis	1.10	1.27	85	70	21	20	40	80	95	90	20	20
Miss:	Jackson	1.26	1.30	70	80	21	11	10	80	45	50	20	20
Mo:	Kansas City	1.07	1.34	80	90	14	15	50	140	35	50	20	40
	St. Louis	1.08	1.37	60	60	16	12	40	80	40	45	20	10
Mont:	Helena	1.14	1.36	80	40	15	14	50	70	85	80	20	40
Nebr:	Omaha	1.12	1.34	85	65	14	16	60	80	50	50	20	20
Nev:	Las Vegas	1.06	1.30	25	30	5	6	30	10	35	45	<10	10
N. H:	Manchester	1.13	1.20	45	55	17	17	30	40	145	120	<10	10
N. J:	Trenton	1.12	1.11	35	50	12	16	20	90	65	70	<10	20
N. Mex:	Albuquerque	1.10	1.31	20	20	5	4	30	20	25	25	10	20
N. Y:	Buffalo	1.10	1.07	35	35	15	14	40	20	70	85	<10	<10
	New York	1.08	1.10	40	55	16	16	40	80	80	75	<10	20
	Syracuse	1.11	1.15	40	35	12	13	40	40	60	75	10	<10
N. C:	Charlotte	1.23	1.29	55	50	23	14	<10	30	50	50	10	20
N. Dak:	Minot	1.11	1.35	100	60	22	24	80	60	80	70	20	<10
Ohio:	Cincinnati	1.12	1.17	45	80	13	20	40	140	40	50	<10	20
	Cleveland	1.11	1.16	30	55	14	14	40	80	55	60	<10	10
Okla:	Oklahoma City	1.16	1.22	60	65	17	16	20	100	45	40	10	20
Ore:	Portland	1.12	1.39	60	200	12	16	20	80	65	70	10	50
Pa:	Philadelphia	1.14	1.12	30	60	14	15	30	130	70	65	<10	20
	Pittsburgh	1.12	1.14	40	70	18	20	30	170	85	80	<10	30
P. R:	San Juan	1.19	[a]—	25	—	11	—	<10	—	35	—	60	—
R. I:	Providence	1.11	1.07	35	55	13	18	20	80	85	85	<10	20
S. C:	Charleston	1.21	1.28	45	40	20	18	10	40	65	60	<10	10
S. Dak:	Rapid City	1.06	1.12	85	50	20	11	70	90	60	70	20	10
Tenn:	Chattanooga	1.25	1.29	65	100	23	15	10	90	55	55	10	30
	Memphis	1.22	1.27	60	80	21	22	10	100	25	45	20	30
Tex:	Austin	1.16	1.24	15	25	6	8	<10	60	20	20	<10	10
	Dallas	1.18	1.25	40	50	14	13	10	80	30	40	<10	20
Utah:	Salt Lake City	1.10	1.36	60	35	12	12	320	30	95	65	40	20
Vt:	Burlington	1.10	1.12	45	60	14	16	20	70	110	85	<10	20
Va:	Norfolk	1.20	1.24	55	50	22	19	10	60	75	65	<10	20
Wash:	Seattle	1.10	1.37	45	145	15	19	30	90	90	85	20	60
	Spokane	1.15	1.40	40	45	14	14	50	40	70	80	10	20
W. Va:	Charleston	1.16	1.26	80	75	24	21	20	70	45	55	10	30
Wis:	Milwaukee	1.10	1.20	30	55	9	14	50	100	60	70	<10	20
Wyo:	Laramie	1.11	1.32	125	40	15	10	190	10	110	60	50	10
Network average		1.14	1.24	49	57	14.8	14.6	40	70	62	62	12	19

[a] Dash indicates no sample.

San Juan, Puerto Rico and Honolulu, Hawaii have had low concentrations (usually comparable to the Southwest) of strontium–89 and iodine–131 in milk during the period August through November 1962.

The November monthly average strontium–90 concentration map (figure 3) appears similar to the one for the previous month. The Southwest reported values below 10 μμc/liter, while all the northern States reported values near 20 μμc/liter. There also seemed to be a ridge of higher (> 20) strontium–90 concen-

139.

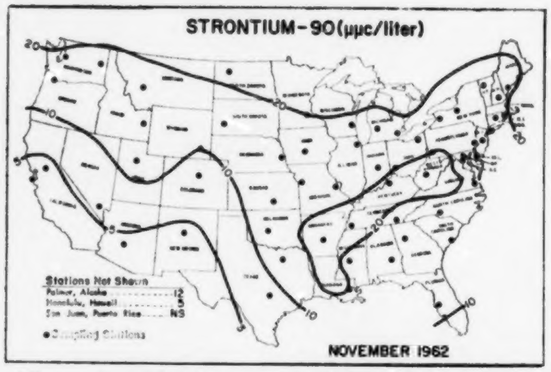
STRONTIUM-90(µµc/liter)
20
10
5
20
10
Stations Not Shown
Palmer, Alaska 12
Honolulu, Hawaii 5
San Juan, Puerto Rico NS
● Sampling Stations
NOVEMBER 1962

Figure 3.—STRONTIUM-90 CONCENTRATIONS IN PASTEURIZED MILK

trations extending from West Virginia to Arkansas and from Arkansas to Louisiana.

Selected Monthly Strontium-90 Profiles

In previous issues of *RHD,* the average monthly strontium-90 concentrations in pasteurized milk from selected cities in the monitoring program were published. Profiles for an additional 15 cities are presented in figure 4. These graphs show the strontium-90 concentrations in milk from selected cities in the U.S. Department of Agriculture marketing regions of the United States.

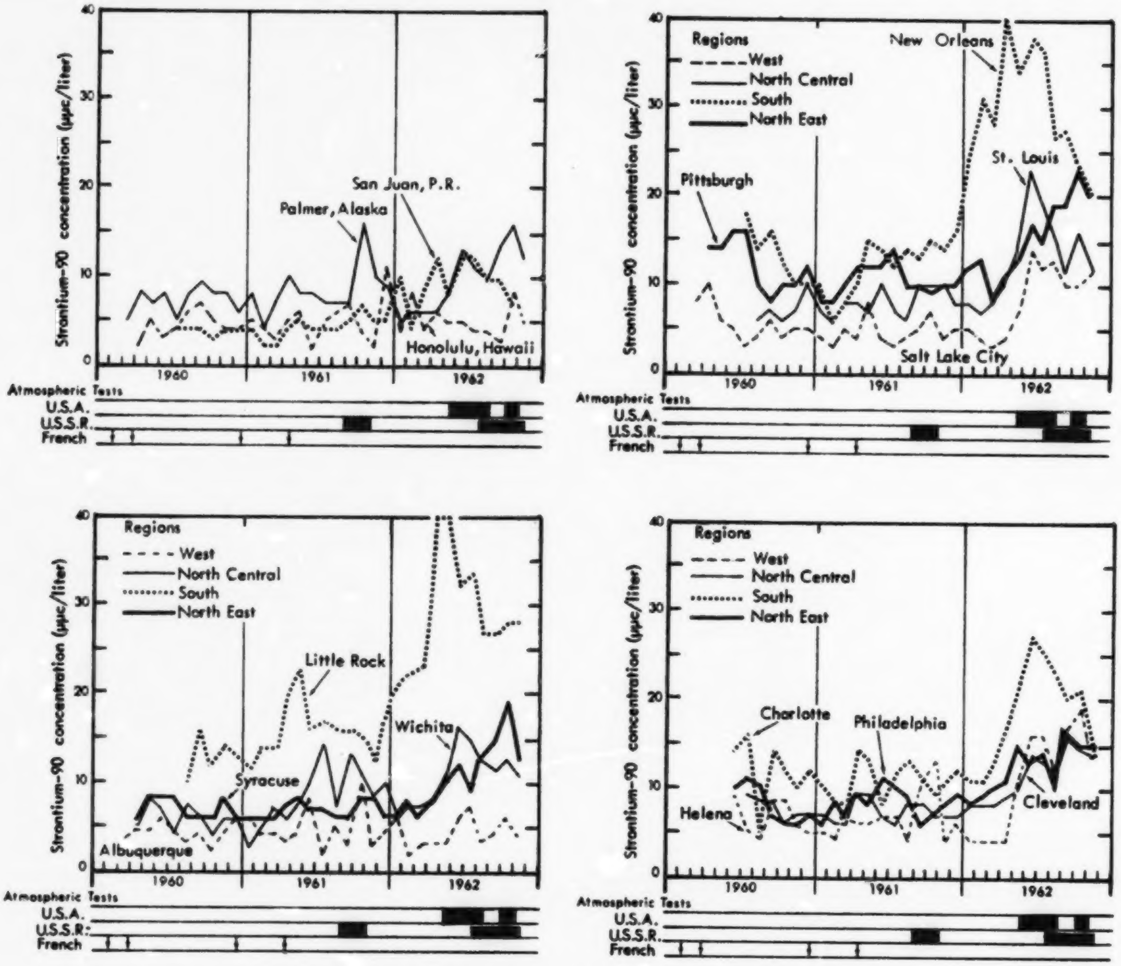

Figure 4.—STRONTIUM-90 CONCENTRATIONS IN PASTEURIZED MILK

INDIANA MILK NETWORK
November–December 1962

Bureau of Environmental Sanitation
Indiana State Board of Health

The Indiana State Board of Health began sampling pasteurized milk for radiological analyses in September 1961. Indiana was geographically divided into five major milksheds, and one large dairy within each milkshed was selected as a sampling station (see figure 5).

The milk samples are routinely analyzed for iodine–131, cesium–137, barium-lanthanum-140, strontium–89, and strontium–90. Analyses for the gamma emitters iodine–131, cesium-137, and barium-lanthanum–140 are conducted on a weekly basis except when iodine–131 results exceed 100 μμc/liter, at which time the frequency of sampling is increased. Strontium–90 analyses are performed monthly on samples which are composited weekly.

The ion exchange analytical procedure (*1*) is used for strontium–89 and strontium–90 analyses. A 512-channel pulse-height analyzer and shielded 4 × 4-inch sodium iodide crystal are used for the gamma analysis of iodine–131, cesium–137, and barium-lanthanum–140.

The monthly averages of the data obtained for the individual sampling stations and the State averages are reported in table 2. The State average is an arithmetic average of the station values.

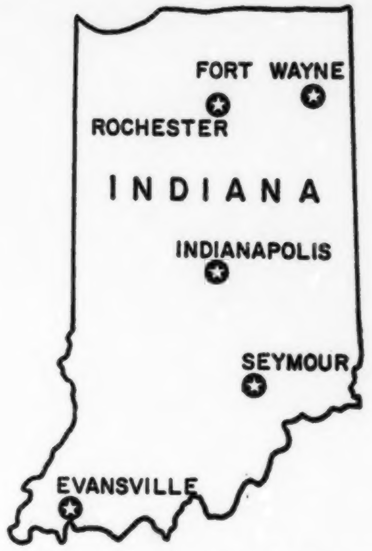

Figure 5.—INDIANA MILK SAMPLING LOCATIONS

REFERENCE

(*1*) Porter, C., and D. Cahill, R. Schneider, P. Robbins, W. Perry, B. Kahn: Determination of Strontium-90 in Milk by an Ion Exchange Method, *Analytical Chemistry 33*:1306–8, 1961.

TABLE 2.—RADIONUCLIDES IN INDIANA MILK, NOVEMBER–DECEMBER 1962

[Concentrations in μμc/liter]

Sampling location	Strontium–89		Strontium–90		Iodine–131		Cesium–137		Barium–140	
	November	December	November	December	November	December	November	December	November	December
Evansville	135	[a]	25	[a]	110	20	40	45	10	<10
Fort Wayne	75	[a]	14	[a]	40	10	50	45	<10	<10
Indianapolis	80	[a]	29	[a]	100	30	45	50	<10	<10
Rochester	60	[a]	23	[a]	60	20	50	50	<10	<10
Seymour	70	[a]	23	[a]	80	30	50	50	<10	10
State average	85	[a]	23	[a]	80	20	45	50	<10	<10

[a] Available next month.

NEW YORK MILK NETWORK
September 1961–October 1962

Division of Special Health Services
State of New York Department of Health

Milk samples, collected routinely from five cities—Albany, Buffalo, Newburgh, New York City, and Syracuse (figure 6) are analyzed for radionuclide content by the State of New York Department of Health. The pasteurized milk samples are collected daily and composited weekly for strontium–89, strontium–90, and iodine–131 analyses.

At Albany and New York City daily iodine–131 analyses have been made. In the event that a city reports iodine–131 concentrations exceeding 100 pc/liter, increased surveillance is undertaken. The matrix method (*1*) is used for the analysis of spectral data to determine the concentrations of gamma-emitting nuclides in milk. With this method, the individual nuclide contributions to the gamma spectrum were separated by solution of simultaneous equations describing the spectral interferences.

The analytical procedure for strontium–89 and strontium–90 is based on ion exchange methods to concentrate the strontium, elution of strontium from the ion exchange resin with sodium chloride, gathering by means of sodium carbonate, isolation by means of ethylenediaminetetraacetic acid (EDTA) and counting with a low background beta counter having a 0.8 mg/cm^2 window. The strontium–90 is differentially estimated by a second count 40 hours later to determine the rate growth of its daughter product, yttrium–90.

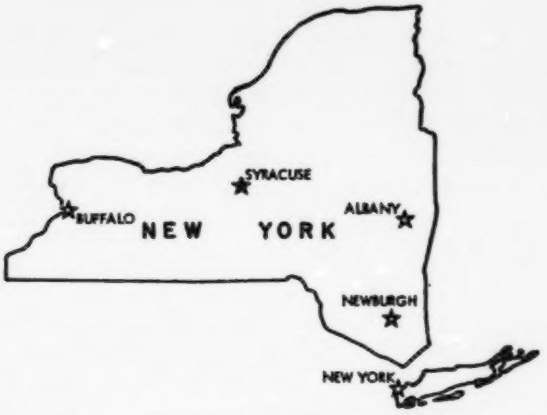

Figure 6.—NEW YORK MILK SAMPLING LOCATIONS

TABLE 3.—RADIONUCLIDES IN NEW YORK MILK, SEPTEMBER 1961–OCTOBER 1962

[Concentrations in pc/liter]

Sampling location and radionuclide	Sep 61	Oct 61	Nov 61	Dec 61	Jan 62	Feb 62	Mar 62	Apr 62	May 62	Jun 62	Jul 62	Aug 62	Sep 62	Oct 62
Albany														
Strontium–89	75 (1)[b]	100 (1)	180 (2)	25 (2)	5 (3)	—[a]	5 (1)	—	55 (17)	90 (3)	30 (4)	25 (5)	25 (4)	50 (4)
Strontium–90	6 (3)	4 (1)	8 (4)	7 (3)	9 (4)	9 (4)	6 (4)	8 (15)	10 (21)	10 (4)	11 (4)	14 (5)	9 (4)	11 (4)
Iodine–131	95 (9)	90 (22)	65 (25)	20 (22)	20 (23)	20 (12)	—	20 (3)	25 (26)	20 (26)	25 (24)	20 (28)	50 (24)	40 (26)
Buffalo														
Strontium–89		265 (1)	460 (1)	25 (2)	—	—	—	—	115 (1)	55 (2)	—	—	35 (1)	42 (6)
Strontium–90		11 (1)	9 (4)	4 (3)	10 (1)	8 (1)	4 (1)	19 (3)	41 (1)	10 (3)	13 (1)	—	7 (1)	9 (6)
Iodine–131		110	65	—	—	—	—	—	—	25	35 (1)	—	40 (4)	45 (5)
Newburgh														
Strontium–89		310 (1)	85 (3)	20 (2)	—	—	—	40 (1)	45 (4)	60 (3)	30 (2)	25 (2)	26 (1)	100 (3)
Strontium–90		10 (1)	10 (3)	7 (3)	—	3 (1)	7 (1)	6 (4)	17 (4)	15 (3)	14 (2)	11 (2)	12 (1)	7 (3)
Iodine–131		60 (2)	20 (1)	—	—	—	—	—	—	20 (3)	20 (3)	20 (2)	50 (8)	45 (7)
New York City														
Strontium–89		—	—	—	—	—	—	—	70 (2)	50 (3)	40 (4)	40 (5)	25 (3)	80 (3)
Strontium–90		—	—	—	—	—	—	—	3 (2)	14 (3)	18 (4)	14 (5)	16 (3)	19 (3)
Iodine–131		—	—	—	—	—	—	—	25 (19)	20 (13)	30 (16)	20 (16)	120 (13)	75 (17)
Syracuse														
Strontium–89		—	110 (2)	15 (1)	11 (1)	—	—	—	55 (3)	97 (1)	20 (2)	20 (1)	28 (4)	45 (3)
Strontium–90		3 (1)	18 (3)	5 (2)	7 (5)	5 (1)	7 (4)	7 (3)	3 (2)	10 (1)	10 (2)	6 (1)	7 (4)	11 (3)
Iodine–131		85 (1)	55 (3)	—	—	—	—	—	—	—	24 (2)	10 (2)	55 (10)	65 (6)

[a] A dash indicates no sample.
[b] Numbers in parentheses indicate the number of samples upon which the monthly average is based.

Table 3 shows the monthly radionuclide concentration averages from September 1961 through October 1962. The numbers in parentheses below the data values are the number of determinations used to compute the monthly average.

REFERENCE

(1) Kahn, B., et al.: *Rapid Methods for Estimating Fission Product Concentrations in Milk, Public Health Service Pub. No. 999–R–2* (in press).

RADIONUCLIDES IN CANADIAN MILK
October 1962

Radiation Protection Division
Department of National Health and Welfare, Ottawa, Canada

Dried Milk Products

Beginning in November 1955, radiochemical analyses of skim milk and buttermilk powders for strontium–90 concentrations were initiated by the Department of National Health and Welfare. Since April 1962, analyses for strontium–89 and cesium–137 have also been included.

Samples are collected through the cooperation of the Dairy Products Division of the Canadian Department of Agriculture, whose dairy products inspectors pick up four 1-pound samples of dried milk from each station (see figure 7) on a monthly schedule.

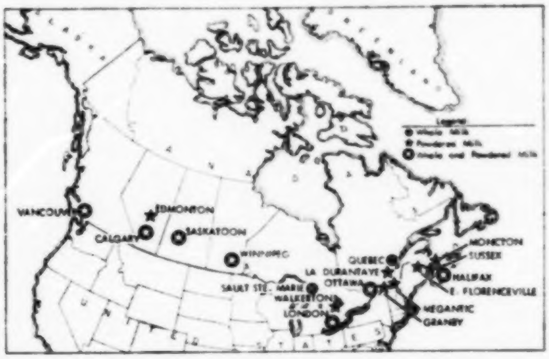

Figure 7.—CANADIAN MILK SAMPLING STATIONS

No statistical plan is followed for sample collection. Because of uncertainties introduced by this method of sampling, the significance of differences between station-to-station and month-to-month results is not precisely known. However, it is possible to consider all results for a given period of time as being sufficiently random in selection to show any national trend when average values for such periods and all stations are plotted, as in figures 8 and 9.

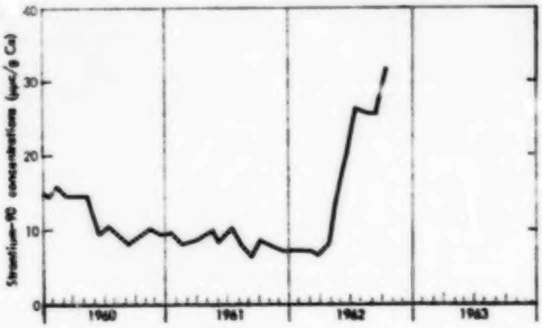

Figure 8.—AVERAGE STRONTIUM–90 CONCENTRATIONS IN CANADIAN DRIED MILK POWDER

A detailed discussion of the sampling and radiochemical procedures employed may be found in the Department's publications (*1*, *2*). Table 4 presents the results of measurements of strontium–89, strontium–90, and cesium–137 in Canadian dried milk powder for October 1962. These data were taken from the "Monthly Report, Radioactive Fallout in Canada," dated December 1962, published by the Radiation Protection Division of the Department of National Health and Welfare.

TABLE 4.—RADIONUCLIDES IN CANADIAN DRIED MILK POWDER, OCTOBER 1962

Station	Strontium-89 (μμc/g Ca)	Strontium-90 (μμc/g Ca)	Cesium-137 (μμc/g K)
Arborg	100.0	26.4	60.0
Calgary	256.0	34.2	117.2
E. Florenceville	167.4	39.1	88.6
Edmonton	222.0	31.0	76.5
Grunthal	119.3	20.8	56.8
Halifax	184.1	35.0	90.2
La Durantaye	284.0	34.3	81.7
Lawrenceville	245.6	42.7	134.1
London	139.9	18.1	56.6
Megantic	314.9	50.6	139.1
Moncton	228.0	47.1	121.4
Nicolet	211.8	28.5	80.0
Ottawa	158.6	17.1	67.9
Saskatoon	127.0	18.0	51.7
Sussex	290.0	47.9	122.1
Vancouver	365.0	34.7	150.6
Walkerton	121.0	18.7	50.0
Average	208.5	32.0	90.9

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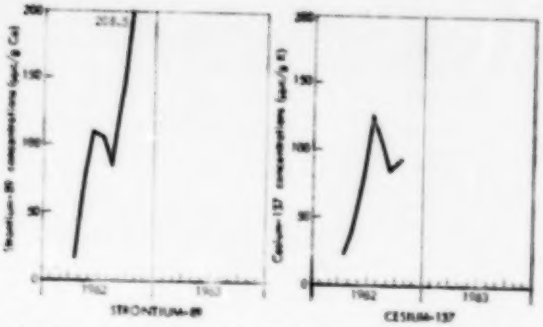

Figure 9.—AVERAGE CONCENTRATIONS IN CANADIAN DRIED MILK POWDER

The network average strontium–90 concentration in milk rose from 26 to 32 μμc/g calcium from September to October.[1] This is an increase of 23 percent. The network average strontium–89 concentrations in milk also increased from 142 to 209 μμc/g calcium from September to October.[1] This is an increase of 47 percent.

For an approximate method to compare the Canadian powdered milk data in units of μμc/g calcium to other milk data in units of μμc/liter, it can be assumed that milk has approximately 1.2 g calcium/liter of liquid milk. Canadian powdered milk data may be compared to liquid milk data by multiplying the former values by 1.2.

The network average cesium–137 concentrations in milk rose from 84 μμc/g potassium in September to 91 μμc/g potassium in October.[1] This is an increase of about 8 percent.

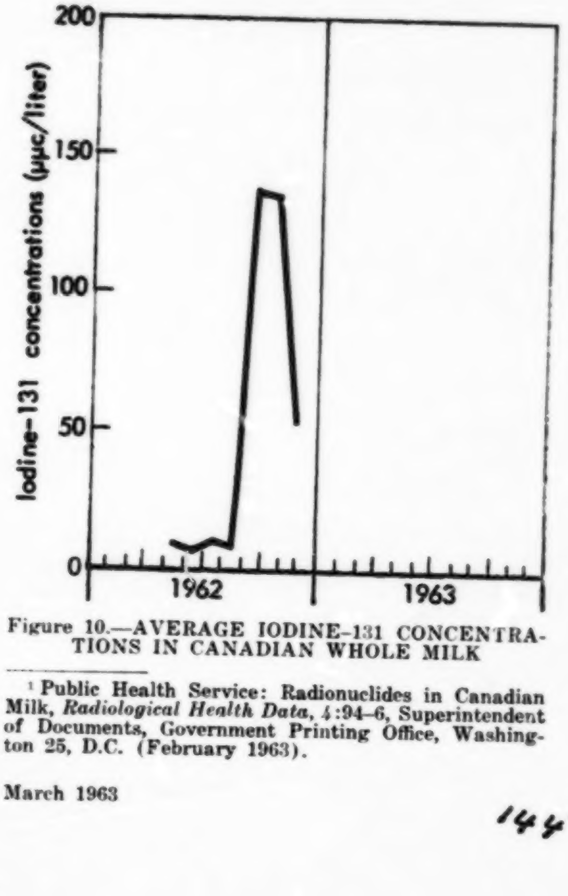

Figure 10.—AVERAGE IODINE–131 CONCENTRATIONS IN CANADIAN WHOLE MILK

Whole Milk

Recently, monitoring of liquid whole milk for iodine–131 was begun. Table 5 presents the October and November average concentrations of iodine–131 in liquid whole milk for nine cities. It may be noted that the average, which increased to about 135 μμc/liter during September and October, has decreased to 51 μμc/liter for November[1] (see figure 10).

TABLE 5.—IODINE–131 IN CANADIAN LIQUID WHOLE MILK, 1962

[Concentrations in μμc/liter]

Station	October[a]	November[a]
Calgary	194	114
Halifax	65	38
London	106	51
Ottawa	103	15
Quebec	197	31
Saskatoon	238	84
Sault Ste. Marie	81	24
Vancouver	92	86
Winnipeg	117	14
Average	134	51

[a] Each monthly average is based on about 13 values.

It should be emphasized again that the interpretation of fallout data in relation to health is a complex problem. In comparing the concentrations in a particular medium with the Maximum Permissible Concentrations (MPC) as established by the International Commission on Radiological Protection (*3*), it is necessary to keep in mind that the MPC values refer to conditions of continuous exposure over a lifetime. Therefore, the average levels over an extended period, such as one year, represent a better basis for comparison than do individual levels at any specific time.

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[1] Public Health Service: Radionuclides in Canadian Milk, *Radiological Health Data*, 4:94–6, Superintendent of Documents, Government Printing Office, Washington 25, D.C. (February 1963).

Previous coverage in *Radiological Health Data*:

Period	Issue
Third quarter 1961	*May 1962*
Fourth quarter 1961	*September 1962*
First quarter 1962	*October 1962*
Second quarter 1962	*January 1963*
Third quarter 1962	*February 1963*

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(*1*) Radiation Protection Division, Department of National Health and Welfare, Ottawa, Canada: *The Preliminary Report on the Measurements of Radioactive Strontium in Canadian Milk Powder Samples, CNHW (RPD–1)*, (July 1958).

(*2*) Mar, Peter G.: *Outline of Procedure for the Radiochemical Analysis of Dried Milk Powders for Strontium and Yttrium, CNHW (RPD–5)*, (June 1, 1960).

(*3*) Recommendations of the International Commission on Radiological Protection: *Report of Committee II on Permissible Dose for Internal Radiation*, Pergamon Press, New York (1959).

Twelve-Month Sum of Daily Radionuclide Content of One Liter of Pasteurized Milk

Iodine–131: January 1962–December 1962
Strontium–89 and strontium–90: December 1961–November 1962

Division of Radiological Health, Public Health Service

The guidance of the Federal Radiation Council (FRC) is given in terms of transient rates of intake of radioactive materials in micromicrocuries per day. The action ranges as proposed in FRC Report No. 2 are based on radiation doses considered acceptable for lifetime exposure from normal peacetime atomic industry operations (*1*). The Council recommends the use of a time period of one year as an appropriate interval for averaging exposures. The Council has recently emphasized that the annual acceptable exposure dose is not a "danger point" which, if exceeded, requires protective measures (*1, 2, 3*).

To facilitate comparison of the concentrations of certain radionuclides in milk with the Radiation Protection Guides, tables 1 and 2 below furnish a means towards estimating the contribution of milk to the total dietary intake of iodine–131, strontium–89, and strontium–90. The tables are based on the same data which are used for computing the Pasteurized Milk Network monthly averages. They present index values which are the estimated sum of the daily amounts of a radionuclide in one liter of milk for a 12-month period.

The tables show 12-month index values for each of the Network's 62 sampling locations. Due to the longer time required for strontium–89 and strontium–90 analysis, these 12-month index values are for the year beginning one month earlier than the iodine–131 values. The columns of monthly index values in each table are used to compute the net change as the yearly index values are advanced by one month. The following column shows this new 12-month index value. In addition, the first column in table 1 gives the iodine–131 December concentration averages.

The data in tables 1 and 2 are calculated as follows: (a) results from all samples collected in each week (Sunday through Saturday) are averaged, (b) the weekly averages for all weeks ending within a given month are averaged and an average for the month is obtained, and (c) the monthly radionuclide index value is determined by multiplying the average for the month by the number of days in the month. The number of days in the month will be either 28 or 35, corresponding to the complete calendar weeks used for any month. Procedures exemplified by (a) and (b) above minimize the effect of any one day's sample results on the average for the month, particularly for a short-lived radionuclide such as iodine–131.

For a number of reasons it is desirable to have a standard quantity of milk to use in the development of index values for the different radionuclides. When one is concerned with strontium, 1 liter is a suitable quantity, as this amount of milk supplies approximately 1 gram of calcium, the amount used by the Federal Radiation Council in deriving the intake guidance for strontium. When one is concerned with iodine–131, the critical age group is the young infant. Available information suggests that the average milk consumption of infants in the 6–18-month group is not more than 1 liter per day. Thus the index value based on 1 liter of milk, though not directly an average intake value, is probably the most useful index for estimating total intake.

REFERENCES

(*1*) Federal Radiation Council: *Background Material for the Development of Radiation Protection Standards, Report No. 2*, Superintendent of Documents, U.S. Government Printing Office (September 1961), price 20 cents.

(*2*) Chadwick, Donald R., and Conrad P. Straub: Considerations in Establishing Radiation Protection Standards for Radioactivity in the Environment, *Radiological Health Data, 3*:159–65, Superintendent of Documents, Government Printing Office, Washington 25, D.C. (May 1962).

(*3*) Public Health Service: Special Report, *Radiological Health Data, 3*:ii–iii, Superintendent of Documents, Government Printing Office, Washington 25, D.C. (September 1962).

TABLE 1.—TWELVE-MONTH SUM OF DAILY AMOUNTS OF IODINE-131 IN ONE LITER OF MILK

[μμc day/liter][a]

Sampling locations		Dec 1962 iodine-131 averages (μμc/liter)	Iodine-131 index values (μμc day/liter)			
			Dec 1961–Nov. 1962	Dec. 1961	Nov. 25, 1962–Dec. 29, 1962	Jan. 1962–Dec. 1962
Ala:	Montgomery	50	4,860	160	1,750	6,450
Alaska:	Palmer	30	36,910	160	1,050	37,800
Ariz:	Phoenix	20	3,870	310	700	4,260
Ark:	Little Rock	170	7,940	620	5,950	13,270
Calif:	Sacramento	20	3,960	310	700	4,350
	San Francisco	30	4,030	160	1,050	4,920
Colo:	Denver	<10	5,700	310	180	5,570
Conn:	Hartford	10	7,180	160	350	7,670
Del:	Wilmington	40	10,490	160	1,400	11,730
D. C:	Washington	30	7,700	310	1,050	8,440
Fla:	Tampa	50	4,690	620	1,750	5,820
Ga:	Atlanta	90	6,260	930	3,150	8,480
Hawaii:	Honolulu	30	3,670	310	1,050	4,410
Idaho:	Idaho Falls	20	8,850	310	700	9,240
Ill:	Chicago	20	13,150	160	700	13,690
Ind:	Indianapolis	50	10,430	310	1,750	11,870
Iowa:	Des Moines	80	19,680	930	2,800	21,550
Kans:	Wichita	80	19,580	930	2,800	21,450
Ky:	Louisville	60	9,060	620	2,100	10,540
La:	New Orleans	110	5,560	930	3,850	8,480
Maine:	Portland	10	7,830	160	350	8,020
Md:	Baltimore	30	7,950	310	1,050	8,690
Mass:	Boston	10	7,910	310	350	7,950
Mich:	Detroit	20	12,140	160	700	12,680
	Grand Rapids	20	8,740	160	700	9,280
Minn:	Minneapolis	20	15,360	310	700	15,750
Miss:	Jackson	100	6,460	1,550	3,500	8,410
Mo:	Kansas City	130	27,060	1,240	4,550	30,370
	St. Louis	30	11,370	310	1,050	12,110
Mont:	Helena	90	11,960	620	3,150	14,490
Nebr:	Omaha	120	16,150	1,240	4,200	19,110
Nev:	Las Vegas[b]	<10	3,780	[c]—	180	3,960
N. H:	Manchester	10	7,100	160	350	7,290
N. J:	Trenton	20	7,450	160	700	7,990
N. Mex:	Albuquerque	40	6,210	160	1,400	7,450
N. Y:	Buffalo	10	8,530	160	350	8,720
	New York	20	11,120	160	700	11,660
	Syracuse	10	9,790	160	350	9,980
N. C:	Charlotte	20	2,830	160	700	3,370
N. Dak:	Minot	10	14,580	160	350	14,770
Ohio:	Cincinnati	60	12,840	620	2,100	14,320
	Cleveland	40	9,860	160	1,400	11,100
Okla:	Oklahoma City	160	13,180	1,240	5,600	17,540
Ore:	Portland	50	8,190	310	1,750	9,630
Pa:	Philadelphia	30	9,790	160	1,050	10,680
	Pittsburgh	50	13,080	160	1,750	14,670
P. R:	San Juan[d]	60	3,390	930	2,100	4,560
R. I:	Providence	20	7,900	160	700	8,440
S. C:	Charleston	70	4,030	310	2,450	6,170
S. Dak:	Rapid City[e]	40	12,710	—	1,400	14,110
Tenn:	Chattanooga	70	6,330	930	2,450	7,850
	Memphis	100	7,370	1,240	3,500	9,630
Tex:	Austin	200	3,960	620	7,000	10,340
	Dallas	330	6,480	310	11,550	17,720
Utah:	Salt Lake City	20	31,240	310	700	31,630
Vt:	Burlington	<10	8,360	160	180	8,380
Va:	Norfolk	40	5,320	310	1,400	6,410
Wash:	Seattle	30	8,910	310	1,050	9,650
	Spokane	20	20,810	160	700	21,350
W. Va:	Charleston	20	6,290	160	700	6,830
Wis:	Milwaukee	20	13,780	160	700	14,320
Wyo:	Laramie	<10	19,970	310	180	19,840

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[a] The data in this table are index values, not to be interpreted as consumption or total intake values. Annual iodine-131 intake per person from milk may be calculated from an index value in this table by applying the appropriate factor representing average individual daily milk consumption for any selected group under consideration.

Example: 12-month I^{131} index (μμc day/liter) × milk consumption factor (liter/day/person) = 12-month I^{131} intake (μμc/person).

[b] Station included in network in July 1962. Value in last column is for 6 months.

[c] Dash indicates no analysis.

[d] No sample was received in November 1962. Twelve-month sums are therefore for 11 months.

[e] Station began operation in January 1962.

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TABLE 2.—TWELVE-MONTH SUM OF DAILY AMOUNTS OF STRONTIUM-89 AND STRONTIUM-90 IN ONE LITER OF MILK

Sampling locations		Strontium-89 index values (μμc day/liter)[a]				Strontium-90 index values (μμc day/liter)[a]			
		Nov. 1961–Oct. 1962	Nov. 1961	Oct. 28, 1962–Nov. 24, 1962	Dec. 1961–Nov. 1962	Nov. 1961–Oct. 1962	Nov. 1961	Oct. 28, 1962–Nov. 24, 1962	Dec. 1961–Nov. 1962
Ala:	Montgomery	18,860	75	1,120	19,905	4,654	180	476	4,950
Alaska:	Palmer	17,845	1,500	1,540	17,885	3,465	300	336	3,501
Ariz:	Phoenix	6,510	300	280	6,490	1,345	390	112	1,067
Ark:	Little Rock	44,020	2,550	3,080	44,550	9,674	390	784	10,068
Calif:	Sacramento	6,125	450	840	6,515	1,324	120	112	1,316
	San Francisco	10,580	150	420	10,850	1,792	60	112	1,844
Colo:	Denver	10,735	750	700	10,685	3,287	150	224	3,361
Conn:	Hartford	7,410	1,200	1,400	7,610	3,681	240	392	3,833
Del:	Wilmington	13,145	2,550	1,960	12,555	4,336	240	448	4,544
D. C:	Washington	12,395	1,500	1,400	12,295	4,613	300	504	4,817
Fla:	Tampa	7,950	900	840	7,890	3,198	180	308	3,326
Ga:	Atlanta	28,035	450	1,260	28,845	6,058	300	420	6,178
Hawaii:	Honolulu	9,460	300	280	9,440	1,909	60	140	1,989
Idaho:	Idaho Falls	8,710	1,050	700	8,360	2,710	120	336	2,926
Ill:	Chicago	11,515	2,700	1,400	10,215	3,604	180	364	3,788
Ind:	Indianapolis	13,525	1,950	1,540	13,115	4,610	270	392	4,732
Iowa:	Des Moines	23,735	2,400	1,960	23,295	4,241	330	308	4,219
Kans:	Wichita	17,660	1,350	1,540	17,850	3,813	240	308	3,881
Ky:	Louisville	24,430	2,100	3,360	25,690	6,241	270	700	6,671
La:	New Orleans	65,550	2,550	1,820	64,820	10,261	420	560	10,401
Maine:	Portland	10,335	1,800	1,820	10,355	4,675	360	448	4,763
Md:	Baltimore	11,635	1,200	1,260	11,695	4,791	210	476	5,057
Mass:	Boston	11,865	2,700	1,680	10,845	5,217	300	560	5,477
Mich:	Detroit	9,995	1,950	1,680	9,725	3,435	210	532	3,757
	Grand Rapids	9,870	2,700	1,120	8,290	3,252	180	420	3,492
Minn:	Minneapolis	22,120	4,200	1,960	19,880	5,063	300	560	5,323
Miss:	Jackson	55,790	2,100	2,240	55,930	8,539	420	308	8,427
Mo:	Kansas City	28,555	2,250	2,520	28,825	4,762	330	420	4,852
	St. Louis	17,965	1,500	1,680	18,145	4,565	300	336	4,601
Mont:	Helena	14,585	750	1,120	14,955	3,557	120	392	3,829
Nebr:	Omaha	22,340	3,000	1,820	21,160	4,055	270	448	4,233
Nev:	Las Vegas[b]	3,045	[c]—	840	3,885	651	—	168	819
N. H:	Manchester	10,385	1,950	1,540	9,975	4,773	330	476	4,919
N. J:	Trenton	9,465	1,350	1,400	9,515	3,802	300	448	3,950
N. Mex:	Albuquerque	5,015	150	560	5,425	1,503	90	112	1,525
N. Y:	Buffalo	9,220	1,800	980	8,400	3,791	180	392	4,003
	New York	10,270	1,800	1,540	10,010	4,637	240	448	4,845
	Syracuse	9,680	1,650	980	9,010	3,650	240	364	3,774
N. C:	Charlotte	18,915	600	1,400	19,715	6,431	330	392	6,493
N. Dak:	Minot	17,650	1,840	1,680	17,490	5,483	270	672	5,885
Ohio:	Cincinnati	17,315	2,400	2,240	17,155	4,777	270	560	5,067
	Cleveland	10,205	1,650	1,540	10,095	3,849	210	392	4,031
Okla:	Oklahoma City	25,040	2,400	1,820	24,460	5,403	240	448	5,611
Ore:	Portland	24,950	5,400	5,600	25,150	4,915	990	448	4,373
Pa:	Philadelphia	9,285	1,500	1,680	9,465	4,207	240	420	4,387
	Pittsburgh	10,510	1,500	1,960	10,970	5,106	300	560	5,366
P. R:	San Juan[d]	24,150	750	—	23,400	3,179	150	—	3,029
R. I:	Providence	10,080	2,700	1,540	8,920	4,151	240	504	4,415
S. C:	Charleston	21,715	450	1,120	22,385	6,225	330	504	6,399
S. Dak:	Rapid City[e]	17,160	—	1,400	18,560	4,474	—	308	4,782
Tenn:	Chattanooga	38,740	1,350	2,800	40,190	7,357	270	420	7,507
	Memphis	36,680	1,950	2,240	36,970	7,063	420	616	7,259
Tex:	Austin	9,525	600	700	9,625	2,290	120	224	2,394
	Dallas	23,000	1,650	1,400	22,750	4,824	300	364	4,888
Utah:	Salt Lake City	10,145	600	980	10,525	2,755	120	336	2,971
Vt:	Burlington	10,545	1,800	1,680	10,425	3,846	330	448	3,964
Va:	Norfolk	17,045	1,500	1,400	16,945	5,784	330	532	5,986
Wash:	Seattle	18,850	2,400	4,060	20,510	5,139	480	532	5,191
	Spokane	11,365	240	1,260	12,385	3,863	180	392	4,075
W. Va:	Charleston	20,180	2,100	2,100	20,180	5,979	300	588	6,267
Wis:	Milwaukee	8,110	1,950	1,540	7,700	2,770	210	392	2,952
Wyo:	Laramie	16,450	75	1,120	17,495	3,127	120	280	3,287

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[a] The data in this table are index values, not to be interpreted as consumption or total intake values. Annual strontium-89 and strontium-90 intake per person from milk may be calculated from an index value in this table by applying the appropriate factor representing average individual daily milk consumption for any selected group under consideration.

Example: 12-month Sr^{89} or Sr^{90} index × milk consumption factor = 12-month Sr^{89} or Sr^{90} intake.
(μμc day/liter) (liter/day/person) (μμc/person)

[b] Station included in network in July 1962. Twelve-month sums are therefore for 4 and 5 months, respectively.

[c] Dash indicates no analysis.

[d] No sample was received for November 1962. December 1961–November 1962 twelve-month sum is therefore for 11 months.

[e] Station began operation in January 1962. Twelve-month sums are therefore for 10 and 11 months, respectively.

SECTION IV.—WATER

Radioactivity in Raw Surface Waters

NATIONAL WATER QUALITY NETWORK
September 1962

Division of Water Supply and Pollution Control, Public Health Service

The National Water Quality Network was initiated in October 1957 (*1*). This network, operated by the Public Health Service in cooperation with State and local agencies, consisted of 123 sampling stations as of the end of September (figure 1). These stations are located on the major waterways used for public water supplies, propagation of fish and wildlife, and recreational, agricultural, and industrial purposes. Samples are taken weekly, monthly, or continuously, depending on the type of analysis and the water quality. These samples are analyzed for plankton population, organic chemicals, chemical, biological, and physical quality, and radioactivity (*2*, *3*).

The radioactivity associated with dissolved solids provides a rough measure of the levels which may be found in treated water, since nearly all of the suspended matter is removed by treatment processes (*4*). It has been observed that in water the natural environmental beta activity is usually several times that of the natural environmental alpha activity. Nuclear installations may contribute additional alpha or beta activity whereas fallout contributes primarily additional beta activity. Gross alpha and beta measurements are made on both suspended and dissolved solids (strontium-90 on the total solids only) in raw surface water samples according to established procedures (*5*, *6*). Because strontium-90 analyses are done quarterly, the results will be published on this basis.

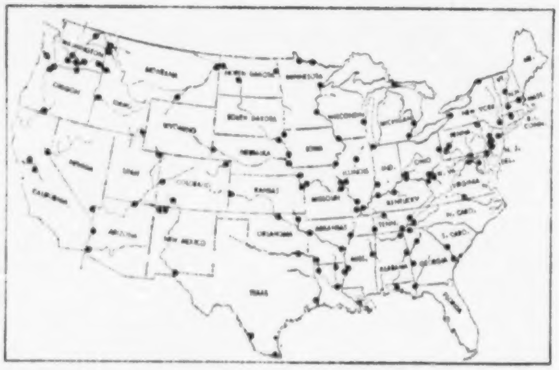

Figure 1.—NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS, SEPTEMBER 1962

For the first two years, beta determinations were made on weekly samples, and alpha determinations were generally made on composites of more than one weekly sample. From January

1960 to September 1961, alpha and beta determinations were generally made once a month on weekly composited samples. Beginning in September 1961, alpha determinations have been made on one sample each month, and beta determinations have generally been made on weekly samples. For the first operating year of each new station, sampling, and alpha and beta analysis are done weekly.

If at any time activity significantly greater than the normal environmental levels has been noted, the rate of sampling and analysis has been increased to at least one every week. Since January 1959, a portion of each sample from all stations in the network has been composited into a three-month station sample for measurement of strontium-90 (*7*).

Table 1 presents the results of the alpha and beta analyses on raw surface water in the United States for September 1962. Table 2 shows the strontium-90 quarterly station averages for April 1961 through March 1962.

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(*3*) Setter, L. R., and S. L. Baker: Radioactivity of Surface Waters in the United States, *Radiological Health Data, 1*:20–31, Superintendent of Documents, Government Printing Office, Washington 25, D.C. (October 1960).

(*4*) Straub, C. P.: Significance of Radioactivity Data, *Journal of the American Water Works Association, 53*:704 (June 1961).

(*5*) Setter, L. R., J. E. Regnier, and E. A. Diephaus: Radioactivity of Surface Waters in the United States, *Journal of the American Water Works Association, 51*:1377 (November 1959).

(*6*) Robert A. Taft Sanitary Engineering Center, Public Health Service: *Radionuclide Analysis of Environmental Samples, Technical Report, R59–6* (1959).

(*7*) Straub, C. P., L. R. Setter, A. Goldin and P. F. Hallbach: Strontium-90 in Surface Waters in the U.S., *Journal of the American Water Works Association, 52*:756 (June 1960).

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS, SEPTEMBER 1962

[Average concentrations in pc/liter]

Station	September 1962					
	Beta activity			Alpha activity		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Allegheny River: Pittsburgh, Pa	3	26	29	0	0	0
Animas River: Cedar Hill, N. Mex	4	30	34	<1	8	8
Apalachicola River: Chattahoochie, Fla	3	4	7	1	0	1
Arkansas River:						
Coolidge, Kans	43	63	106	0	40	40
Ponca City, Okla	148	27	175	13	1	14
Pendleton Ferry, Ark	—	—	—	—	—	—
Bear River: Preston, Idaho	11	38	49	<1	1	1
Bighorn River: Hardin, Mont	82	42	124	6	6	12
Big Sioux River: Sioux Falls, S. Dak	32	65	97	1	1	2
Chattahoochie River:						
Atlanta, Ga	5	7	12	0	0	0
Columbus, Ga	9	9	18	0	0	0
Lanett, Ala	9	10	19	<1	0	<1
Chena Slough: Fairbanks, Alaska	13	25	38	<1	0	<1
Clear Water River: East Lewiston, Idaho	5	10	15	0	0	0
Clinch River:						
Kingston, Tenn	130	7	137	1	0	1
Clinton, Tenn	5	5	10	0	0	0
Colorado River:						
Loma, Colo	47	57	104	7	10	17
Page, Ariz	325	43	368	19	11	30
Boulder City, Nev	7	28	35	0	8	8
Parker Dam, Calif.-Ariz	18	33	51	0	6	6
Yuma, Ariz	120	63	183	1	0	1
Columbia River:						
Northport, Wash	3	13	16	0	<1	<1
Wenatchee, Wash	4	8	12	0	0	0
Pasco, Wash	53	247	300	0	0	0
McNary Dam, Ore	21	238	259	0	0	0
Bonneville, Ore	9	127	136	—	—	—
Clatskanie, Ore	7	101	108	0	0	0
Connecticut River:						
Wilder, Vt	15	13	28	0	1	1
Northfield, Mass	4	14	18	0	0	0
Enfield Dam, Conn	8	12	20	<1	0	<1
Delaware River:						
Martins Creek, Pa	5	10	15	1	0	1
Trenton, N. J	2	12	14	0	<1	<1
Philadelphia, Pa	5	14	19	0	0	0
Escambia River: Century, Fla	19	3	22	0	0	0
Great Lakes:						
Duluth, Minn	3	4	7	—	—	—
Sault Ste. Marie, Mich	4	10	14	0	0	0
Milwaukee, Wis	1	8	9	0	<1	<1
Gary, Ind	3	12	15	0	0	0
Port Huron, Mich	6	6	12	0	0	0
Detroit, Mich	2	3	6	0	0	0
Buffalo, N. Y	18	10	28	0	0	0
Green River: Dutch John, Utah	15	18	33	2	3	5
Hudson River: Poughkeepsie, N. Y	4	28	32	1	0	1
Illinois River:						
Peoria, Ill	11	22	33	1	0	1
Grafton, Ill	14	22	36	1	1	2
Kanawha River: Winfield Dam, W. Va	13	15	28	—	—	—
Klamath River: Keno, Ore	3	10	13	0	0	0
Little Miami River: Cincinnati, Ohio	15	30	45	0	0	0
Mississippi River:						
St. Paul, Minn	8	32	40	0	2	2
Dubuque, Iowa	10	21	31	0	1	1
Burlington, Iowa	19	28	47	0	2	2
E. St. Louis, Ill	15	23	38	0	2	2
Cape Girardeau, Mo	36	25	61	1	2	3
W. Memphis, Ark	22	24	46	3	1	4
Delta, La	14	23	37	0	1	1
New Orleans, La	4	16	20	1	2	3
Vicksburg, Miss	20	26	46	1	1	2

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS, SEPTEMBER 1962—Continued

[Average concentrations in pc/liter]

Station	September 1962					
	Beta activity			Alpha activity		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Missouri River:						
Williston, N. Dak	33	18	51	0	4	4
Bismarck, N. Dak	10	34	44	1	4	5
Yankton, S. Dak	9	36	45	—	—	—
Omaha, Nebr	81	34	115	3	3	6
St. Joseph, Mo	144	48	192	5	3	8
Kansas City, Kans	91	35	126	3	3	6
St. Louis, Mo	50	36	86	1	2	3
Missouri City, Mo	158	30	188	22	3	25
Monongahela River: Pittsburgh, Pa	4	32	36	0	0	0
North Platte River: Henry, Nebr	11	51	62	1	20	21
Ohio River:						
E. Liverpool, Ohio	—	—	—	—	—	—
Addison, Ohio	8	22	30	<1	0	<1
Huntington, W. Va	6	20	26	0	0	0
Cincinnati, Ohio	10	16	26	0	0	0
Louisville, Ky	4	18	22	0	0	0
Evansville, Ind	5	36	41	0	3	3
Cairo, Ill	5	16	21	0	0	0
Ouachita River: Bastrop, La	7	19	26	0	<1	<1
Pend Oreille River: Albeni Falls Dam, Idaho	2	7	9	0	0	0
Platte River: Plattsmouth, Nebr	134	42	176	6	1	7
Potomac River:						
Williamsport, Md	6	18	24	—	—	—
Great Falls, Md	6	16	22	0	1	1
Rainy River:						
Baudette, Minn	14	43	57	0	0	0
International Fls. Minn	13	18	31	0	0	0
Red River, South:						
Denison, Tex	225	104	329	—	—	—
Index, Ark	82	25	107	22	1	23
Bossier City, La	19	270	289	3	2	5
Alexandria, La	92	19	111	0	1	1
Rio Grande River:						
Alamosa, Colo	14	16	30	<1	2	2
El Paso, Tex	35	35	70	0	5	5
Laredo, Tex	204	26	230	103	4	107
Brownsville, Tex	4	17	21	—	—	—
Roanoke River: John H. Kerr Resr. & Dam, Va	3	10	13	0	0	0
Sabine River: Ruliff, Tex	22	12	34	0	1	1
Sacramento River: Greens Landing, Courtland, Calif	3	4	7	0	0	0
San Joaquin River: Vernalis, Calif	12	14	26	1	8	9
San Juan River: Shiprock, N. Mex	25	33	58	1	7	8
St. Lawrence River: Massena, N. Y	4	10	14	1	1	2
Schuylkill River: Philadelphia, Penn	0	17	17	—	—	—
Savannah River:						
North Augusta, S. C	5	11	16	0	0	0
Port Wentworth, Ga	5	19	24	1	0	1
Shenandoah River: Berryville, Va	17	16	33	<1	0	<1
Snake River:						
Ice Harbor Dam, Wash	2	15	17	<1	2	2
Wawawai, Wash	3	15	18	0	1	1
Payette, Idaho	6	18	24	0	3	3
South Platte River: Julesburg, Colo	8	68	76	0	24	24
Spokane River: Post Falls, Idaho	5	8	13	<1	0	<1
Susquehanna River:						
Sayre, Pa	4	10	14	0	0	0
Conowingo, Md	4	18	22	0	<1	<1
Tennessee River:						
Chattanooga, Tenn	5	20	25	0	1	1
Bridgeport, Ala	3	13	16	0	0	0
Pickwick Landing, Tenn	16	38	54	1	0	1
Lenoir City, Tenn	12	10	22	0	0	0
Tombigbee River: Columbus, Miss	9	7	16	<1	0	<1
Truckee River: Farad, Calif	26	20	46	<1	0	<1
Verdigris River: Nowata, Okla	104	36	140	7	<1	7
Wabash River: New Harmony, Ind	22	27	49	2	<1	2
Willamette River: Portland, Ore	4	4	8	<1	0	<1
Yakima River: Richland, Wash	1	12	13	0	1	1
Yellowstone River: Sidney, Mont	48	31	79	—	—	—

TABLE 2.—QUARTERLY STATION AVERAGE CONCENTRATIONS OF STRONTIUM-90 IN RAW SURFACE WATERS, APRIL 1961–MARCH 1962

[μμc/liter]

Station	Second quarter 1961	Third quarter 1961	Fourth quarter 1961	First quarter 1962
Allegheny River: Pittsburgh, Pa	0.2	0.3	0.6	1.7
Animas River: Cedar Hill, N. Mex	[a]—	0.3	0.9	0.8
Apalachicola River:				
Chattahoochie, Fla	—	0.4	0.5	[b] 0.9
Arkansas River:				
Coolidge, Kansas	—	2.3	1.0	0.6
Ponca City, Okla	0.7	—	0.6	1.3
Pendleton Ferry, Ark	—	—	0.5	1.3
Bighorn River: Hardin, Mont	—	—	—	[b] 1.5
Big Sioux River:				
Sioux Falls, S. Dak	—	0.4	1.2	2.0
Chattahoochie River:				
Atlanta, Ga	0.3	—	0.3	0.5
Columbus, Ga	—	—	0.1	0.6
Clear Water River:				
Lewiston, Idaho	—	—	0.3	0.5
Colorado River:				
Loma, Colo	—	—	0.8	1.2
Page, Ariz	2.3	—	1.9	1.5
Boulder City, Nev	—	1.0	1.8	1.3
Parker Dam, Calif.-Ariz	—	—	1.5	1.0
Yuma, Ariz	—	—	0.7	0.6
Columbia River:				
Wenatchee, Wash	—	—	0.7	0.9
Pasco, Wash	—	1.1	0.7	1.1
McNary Dam, Ore	—	1.2	0.6	0.9
Bonneville Dam, Ore	—	0.6	0.8	1.1
Clatskanie, Ore	1.1	—	0.6	0.7
Connecticut River:				
Wilder, Vt	—	—	3.7	0.8
Northfield, Mass	—	0.4	0.4	0.6
Cumberland River:				
Clarksville, Tenn				
Delaware River:				
Martins Creek, Pa	0.4	—	0.5	0.7
Trenton, N.J	—	—	0.7	1.0
Philadelphia, Pa	—	—	—	[b] 0.7
Escambia River: Century, Fla	—	0.9	0.5	0.4
Great Lakes:				
Duluth, Minn	—	—	0.1	0.8
Sault Ste. Marie, Mich	—	—	0.5	0.5
Milwaukee, Wis	0.3	—	0.8	0.5
Gary, Ind	—	0.2	0.1	0.9
Port Huron, Mich	—	0.4	0.8	0.8
Detroit, Mich	—	0.6	0.4	1.1
Buffalo, N.Y	—	—	0.8	1.0
Hudson River: Poughkeepsie, N.Y.	0.5	0.2	2.5	1.1
Illinois River:				
Peoria, Ill	—	0.4	0.7	1.0
Grafton, Ill	—	—	0.6	2.5
Kanawha River:				
Winfield Dam, W. Va	—	—	0.5	0.4
Klamath River: Keno, Ore	0.3	—	1.2	1.1
Little Miami River:				
Cincinnati, Ohio	—	1.1	0.6	1.3
Merrimack River: Lowell, Mass	—	0.7	—	—
Mississippi River:				
St. Paul, Minn	—	0.9	0.6	1.3
Dubuque, Iowa	—	—	0.8	0.7
Burlington, Iowa	—	0.6	1.9	1.0
E. St. Louis, Ill	0.5	—	0.9	1.2
Cape Girardeau, Mo	—	0.8	1.0	1.4
W. Memphis, Ark	—	—	1.1	1.5
Delta, La	—	[b] 0.4	1.8	1.0
New Orleans, La	0.6	—	0.7	1.4
Vicksburg, Miss	—	—	0.7	2.0
Missouri River:				
Williston, N. Dak	—	—	1.2	1.4
Bismarck, N. Dak	0.6	—	1.1	1.4
Yankton, S. Dak	—	0.6	2.5	0.7
Omaha, Nebr	0.7	—	0.7	1.0
St. Joseph, Mo	—	—	0.5	1.1
Kansas City, Kans	—	—	0.9	0.5
St. Louis, Mo	—	1.4	2.1	1.3
Missouri City, Mo	—	—	—	1.5
Monongahela River:				
Pittsburgh, Pa	—	0.4	1.3	0.7
North Platte River: Henry, Nebr	—	—	1.3	0.5
Ohio River:				
E. Liverpool, Ohio	—	0.4	—	1.2
Huntington, W. Va	—		1.0	0.6
Cincinnati, Ohio	—	—	0.6	1.2
Louisville, Ky	—	0.4	0.7	1.3
Cairo, Ill	—	1.1	—	1.4
Ouachita River: Bastrop, La	—	—	0.7	2.0
Platte River: Plattsmouth, Nebr	—	—	—	2.2

TABLE 2.—QUARTERLY STATION AVERAGE CONCENTRATIONS OF STRONTIUM-90 IN RAW SURFACE WATERS, APRIL 1961–MARCH 1962—Continued

[μμc/liter]

Station	Second quarter 1961	Third quarter 1961	Fourth quarter 1961	First quarter 1962
Potomac River				
Williamsport, Md	0.8	—	0.9	0.5
Great Falls, Md	—	—	0.6	1.1
Rainy River:				
International Fls, Minn	—	—	0.3	1.4
Baudette, Minn	—	—	—	1.4
Red River North:				
Grand Forks, N. Dak	1.5	—	—	—
Red River South:				
Denison, Tex	—	—	2.2	2.2
Index, Ark	—	—	1.7	2.1
Alexandria, La	—	1.0	2.7	1.1
Rio Grande River:				
Alamosa, Colo	—	0.4	—	[b] 0.6
El Paso, Tex	—	—	—	[b] 0.5
Laredo, Tex	—	—	0.6	0.4
Brownsville, Tex	0.3	—	0.6	0.9
Roanoke River:				
John H. Kerr Resr. & Dam, Va	—	—	0.6	0.6
Sabine River: Ruliff, Tex	0.8	—	0.7	1.3
San Juan River: Shiprock, N. Mex	—	—	1.3	1.9
St. Lawrence River: Massena, N.Y	—	—	1.6	0.8
Schuylkill River: Philadelphia, Pa	—	—	—	[b] 0.6
Savannah River:				
North Augusta, S.C	0.5	—	—	0.8
Port Wentworth, Ga	0.5	0.4	0.7	0.9
Shenandoah River: Berryville, Va	—	—	0.2	0.4
Snake River:				
Wawawai, Wash	—	0.3	0.2	0.9
Payette, Idaho	—	—	2.5	0.3
South Platte River:				
Julesburg, Colo	—	0.7	1.2	0.8
Susquehanna River:				
Sayre, Pa	—	0.3	0.2	0.9
Conowingo, Md	—	0.3	0.9	0.5
Tennessee River:				
Chattanooga, Tenn	—	0.6	0.5	0.6
Bridgeport, Ala	0.9	0.7	1.5	2.0
Pickwick Landing, Tenn	—	—	0.4	1.3
Lenoir City, Tenn	—	—	—	1.2
Tombigbee River: Columbus, Miss	—	—	0.2	0.9
Truckee River: Farad, Calif	—	—	0.1	0.8
Wabash River: New Harmony, Ind	—	—	—	1.3
Yakima River: Richland, Wash	—	0.4	0.6	0.6
Yellowstone River: Sidney, Mont	0.8	—	1.2	1.3

[a] Dash denotes no sample received or no determinations made.

[b] Six months composite—added period required to obtain sufficient sample for analysis.

SECTION V.—OTHER DATA

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission receives from its contractors quarterly reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

Summaries of the environmental radioactivity data for 22 AEC installations have appeared periodically in *Radiological Health Data* since November 1960. Summaries follow for Feed Materials Production Center and Mound Laboratory.

The measured concentration of a radionuclide in air and water may be compared with the Maximum Permissible Concentration (MPC) of that nuclide as recommended by the National Committee on Radiation Protection and Measurement (NCRP). For the environment near an AEC installation, the applicable MPC's are one-tenth of the occupational MPC values for continuous exposure given in the National Bureau of Standards "Handbook 69" (*1*). The MPC values applicable to the reports that follow are given in table 1.

In these reports, nonspecific terms such as "total activity," "total alpha," and "gross beta" do not in themselves suggest any one MPC value. Often, when concentrations are low a

TABLE 1.—SELECTED ENVIRONMENTAL MPC VALUES PERTAINING TO AEC INSTALLATION REPORTS IN THIS SUBSECTION

Line no.	Radionuclide or mixture of unknown nuclides	Environmental MPC's	
		Water ($\mu\mu c$/liter)	Air ($\mu\mu c$/m^3)
1	If Sr^{90}, I^{129}, Pb^{210}, Po^{210}, At^{211}, Ra^{223}, Ra^{224}, Ra^{226}, Ac^{227}, Ra^{228}, Th^{230}, Pa^{231}, Th^{232}, and Th-nat are not present[a]	3,000	—
2	If Sr^{90}, Pb^{210}, Ra^{226}, Ra^{228} are not present[a]	600	—
3	If Ra^{226}, Ra^{228} are not present[a]	100	—
4	Mixture of unidentified nuclides	10	0.04
5	If α emitters and Ac^{227} are not present[a]	—	1.0
6	If α emitters and Pb^{210}, Ac^{227}, Ra^{228}, Pu^{241} are not present[a]	—	10
7	If α emitters and Sr^{90}, I^{129}, Pb^{210}, Ac^{227}, Ra^{228}, Pa^{230}, Pu^{241}, Bk^{249} are not present[a]	—	100
8	Plutonium-239	5,000	0.06
9	Polonium-210	700	20
10	Hydrogen-3 (tritium)	3,000,000	200,000
11	Uranium-natural	20,000	2

[a] "Not present" implies that the concentration of the nuclide is small compared with its appropriate MPC. According to AEC regulation (Federal Register, Title 10, Part 20, August 9, 1961), a group of nuclides may be considered not present if the ratio of each nuclide to its appropriate MPC is equal to or less than 1/10 and if the sum of these ratios for the group in question is equal to or less than 1/4.

laboratory will assign an MPC value that is more restrictive than necessary. This avoids the more costly isotopic tests necessary to justify a less restrictive value. References to table 1 will be made to designate the appropriate MPC's adopted by the respective laboratories. As these terms arise in the following reports, the reader is referred to lines in table 1 which show the appropriate MPC's adopted by the respective laboratories.

REFERENCE

(*1*) National Committee on Radiation Protection: *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure, National Bureau of Standards Handbook 69,* Superintendent of Documents, Government Printing Office, Washington 25, D.C. (June 5, 1962), price 35 cents.

FEED MATERIALS PRODUCTION CENTER

National Lead Company
Fernald, Ohio

Second Half 1961–First Half 1962

The Feed Materials Production Center (FMPC), located in southwestern Ohio, is operated by the National Lead Company of Ohio (NLO) for the AEC. The location, as related to populated areas, is shown in figure 1.

Operations at this project deal with the processing of high-grade uranium ores and ore concentrates to produce metallic uranium and with the fabrication of the metal into fuel elements.

To check the effectiveness of dust collectors and waste treatment processes, an environmental survey program of air and water sampling is maintained.

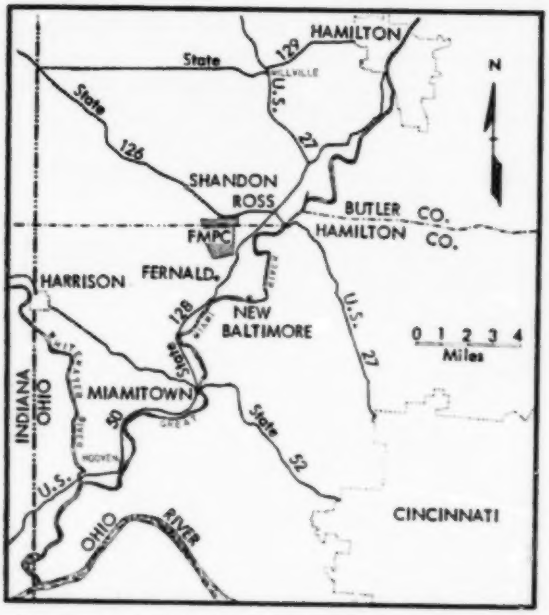

Figure 1.—AREA MAP OF FEED MATERIALS PRODUCTION CENTER

This report presents a summary of the data for this program for the second half of 1961 and first half of 1962.

Air Monitoring

FMPC uses dust collectors such as bag collectors, electrostatic precipitators and scrubbing towers which remove nearly all of the airborne particulates generated during the many plant operations. The environmental air sampling program provides an indication of the amount of material released into the atmosphere.

On-site samples were taken by four permanent sampling stations located at the four corners of the production area shown in figure 2. Off-site samples were taken by a mobile unit operated at various distances and directions from the plant. The data for the off-site samples are averaged in groups according to distance from the production area. Concentrations of uranium and total activity of airborne particulates sampled at on-site and off-site locations are given in table 2.

Water Monitoring

Continuous daily samples, collected from the combined sewer leading from the FMPC site to the Great Miami River are analyzed for uranium and total activity. The combined sewage is composed of treated liquid effluent from

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TABLE 2.—RADIOACTIVITY OF AIRBORNE PARTICULATES, FMPC

[Average concentrations in $\mu\mu c/m^3$]

Location	Second half 1961			First half 1962		
	Number of samples	Uranium[a]	Total activity[b]	Number of samples	Uranium[a]	Total activity[b]
On-site:						
Southwest	[illegible]	0.14	1.83	27	0.27	3.21
Northwest	25	0.14	1.79	27	0.08	2.95
Northeast	24	0.14	2.12	27	0.14	3.00
Southeast	23	0.13	1.38	27	0.16	2.81
All on-site samples	96	0.14	1.77	108	0.16	2.99
Off-site:						
0–2 miles from FMPC	25	0.07	0.32	5	0.09	2.24
2–4 miles from FMPC	22	0.04	0.22	2	0.12	2.11
4–8 miles from FMPC	11	0.02	0.65	4	0.03	1.66
8–10 miles from FMPC	9	0.02	0.56	3	0.03	1.17
All off-site samples	67	0.05	0.38	14	0.07	1.80

[a] Refer to table 1 line 11.
[b] Refer to table 1 line 7.

the production plants, water treatment plants waste effluent, storm sewer discharge, and treated sanitary sewage. Using the data from the combined sewage samples and stream flow data for the Great Miami River, the FMPC contribution to radioactivity concentrations in the river may be calculated. To check the calculated results, weekly upstream and downstream spot samples are taken. Table 3 presents a comparison of the calculated and the spot check river concentrations. Sampling points are shown in figure 2.

Previous coverage in *Radiological Health Data*:

Period	Issue
1959, First half 1960	*April 1961*
Second half 1960, annual summary 1960	*June 1961*
First and second quarters 1961	*December 1961*

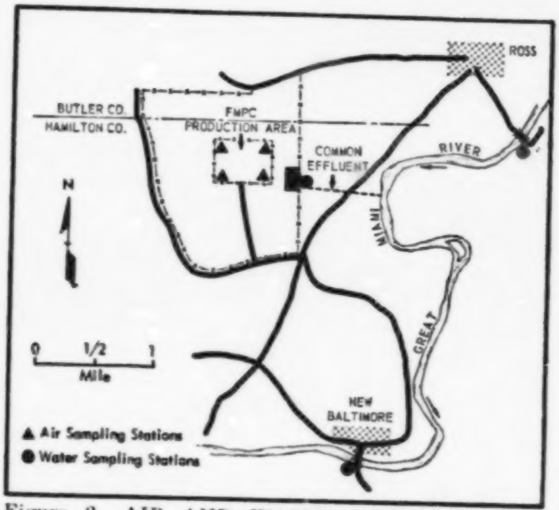

Figure 2.—AIR AND WATER SAMPLING STATIONS, FEED MATERIALS PRODUCTION CENTER

TABLE 3.—CONCENTRATIONS OF URANIUM AND TOTAL ACTIVITY IN THE GREAT MIAMI RIVER, OHIO

[Average concentrations in $\mu\mu c$/liter]

Location	Method of determination	Second half 1961			First half 1962		
		Number of samples	Uranium[a]	Total activity[b]	Number of samples	Uranium[a]	Total activity[b]
Sewer outfall	Calculated from sewer concentrations and stream data (continuous sampling).	184	8	12	181	5	6
Upstream	Spot samples	29	9	34	31	11	64
Downstream	Spot samples	29	10	39	31	11	66

[a] Refer to table 1 line 11.
[b] Refer to table 1 line 1.

MOUND LABORATORY

Monsanto Chemical Company
Miamisburg, Ohio

First Half 1962

During the first half of 1962 none of the radioactive materials used by Mound Laboratory (ML) contributed measurable penetrating radiation to the environment. Possible air contaminants were plutonium, polonium, and tritium; possible river water contaminants were polonium and tritium. The Laboratory uses as its guides the environmental MPC's as determined from NBS "Handbook 69" (see table 1).

Air Monitoring

A continuous air monitor for measurement of tritium and particulate air sampling equipment for measurement of alpha activity mounted on a one-ton panel truck are used in the routine monitoring of the environmental air at 95 locations selected within a radius of 20 miles. The choice of sites on a given day depends on the wind direction at the time of collection.

A total of 362 samples were taken for determination of tritium in air during the first half of 1962. In all cases the tritium concentrations were below detectable levels.

Monitoring for possible polonium and plutonium released to the environment is accomplished by determination of long-lived gross alpha on filter paper samples. Counting was done in a low-background proportional counter after sufficient time had elasped after collection to permit the decay of short-lived daughter products of radon and thoron. The measured concentrations of alpha activity in air are summarized in table 4. For purposes of comparison, upwind and downwind activities for the fourth quarter 1961 were 0.016 and 0.025 $\mu\mu c/m^3$, respectively.

Water Monitoring

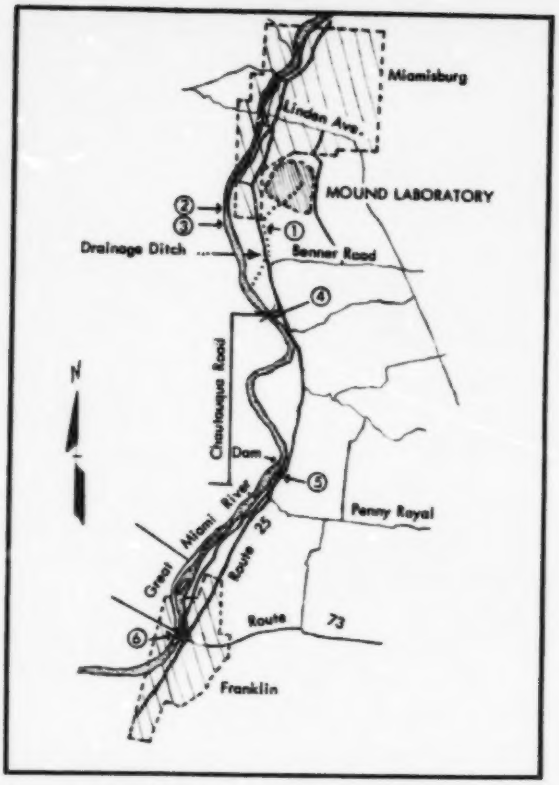

Figure 3.—WATER SAMPLING LOCATIONS IN GREAT MIAMI RIVER, MOUND LABORATORY

TABLE 4.—WIND EFFECT ON LONG-LIVED ALPHA CONCENTRATIONS IN AIR, ML, 1962

Direction from laboratory relative to wind	First quarter		Second quarter	
	Number of samples	Alpha [a] ($\mu\mu c/m^3$)	Number of samples	Alpha [a] ($\mu\mu c/m^3$)
Upwind	30	0.0033	17	0.0005
Downwind	178	0.0029	137	0.0014

[a] May be compared with table 1 lines 8 and 9.

Liquid radioactive waste materials from polonium work at the Laboratory are processed in a special waste disposal plant designed to reduce radioactivity to a concentration level at which it may be discharged to the Great Miami River (station 2 in figure 3). Liquid waste from the plutonium work is small in volume. It is handled separately as a packaged waste and is not discharged to the river. Helium-3, which is purified at the Mound Laboratory, yields small quantities of tritium. Liquid wastes from this work, also small in volume, are treated separately (diluted with water when necessary) to assure that the radioactive content is below the maximum permissible concentration for discharge to the Great Miami River.

Weekly water samples are collected from a drainage ditch and five locations along the Great Miami River as shown in figure 3. The drainage ditch carries away all storm sewer water and liquid tritium wastes from the plant site. Sampling location number 2 is located at the point of discharge of the laboratory effluent to the Great Miami River. Number 6 is five miles downstream from the effluent discharge. Additional single downstream samples were collected at five locations (beyond the limits of the map in figure 3) during the first quarter.

All of the river samples are analyzed for polonium concentration. The drainage ditch samples and some of the river samples are analysed for tritium. Average concentrations of tritium are given in table 5.

Previous coverage in *Radiological Health Data*:

Period	Issue
1959 and first quarter 1960	*November 1960*
Second quarter 1960	*February 1961*
Third and fourth quarters 1960	*May 1961*
First and second quarters 1961	*January 1962*
Third and fourth quarters 1961	*June 1962*

TABLE 5.—OFF-SITE WATER MONITORING FOR POLONIUM AND TRITIUM, ML

[Average concentrations in μμc/liter]

Station code number (see figure 5)	First quarter 1962				Second quarter 1962			
	Tritium[a]		Polonium[b]		Tritium[a]		Polonium[b]	
	Number of Samples	Concentration	Number of Samples	Concentration	Number of Samples	Concentration	Number of Samples	Concentration
1	9	70,000	0	—	11	50,000	0	—
2[c]	9	40,060	9	0.40	9	30,000	9	15.7
3	0	—	8	0.22	0	—	11	0.63
4	8	13,000	8	0.45	11	40,000	11	0.32
5	0	—	9	0.20	0	—	11	4.95
6	0	—	9	0.40	0	—	11	0.63
Others[d]	0	—	0	—	0	—	6	0.6

[a] Refer to table 1 line 10.

[b] Refer to table 1 line 9.

[c] Station 2 is Mound Laboratory effluent.

[d] Single samples are semiannually collected at six downstream locations between Franklin and Elizabethtown, Ohio.

Reported Nuclear Detonations

FEBRUARY 1963

During the past two months, two announcements of nuclear detonations were made by the Atomic Energy Commission. Both announcements were for detonations taking place in February. The first announcement reported the resumption of underground testing on February 8 at the Nevada Test Site, but the total number of detonations was not indicated; therefore, in the tabulation below, the numbering arbitrarily shows one test on that date.

Two detonations were announced on February 21, one of which was described as a weapons development test and the other was identified with the "Plowshare" series of tests involving peaceful uses of nuclear exposives.

TABLE 1.—SUMMARY OF NUCLEAR DETONATIONS REPORTED DURING FEBRUARY 1963

Test number	Location	Date	Yield range [a]	Type of Test
[b] 98	Nevada Test Site	February 8	"Intermediate or less"	Underground
99	Nevada Test Site	February 21	Low	Underground
[c] 100	Nevada Test Site	February 21	Low	Underground

[a] Low yield range has been announced as less than 20 kilotons yield; intermediate yield is in the range of 20 kilotons up to 1 megaton; and low megaton yield is in the range from 1 to several megatons.

[b] Unspecified number of tests were conducted on this date.

[c] Third "Plowshare" Program test reported in *Radiological Health Data* since the tabulation was started in the fall of 1961.